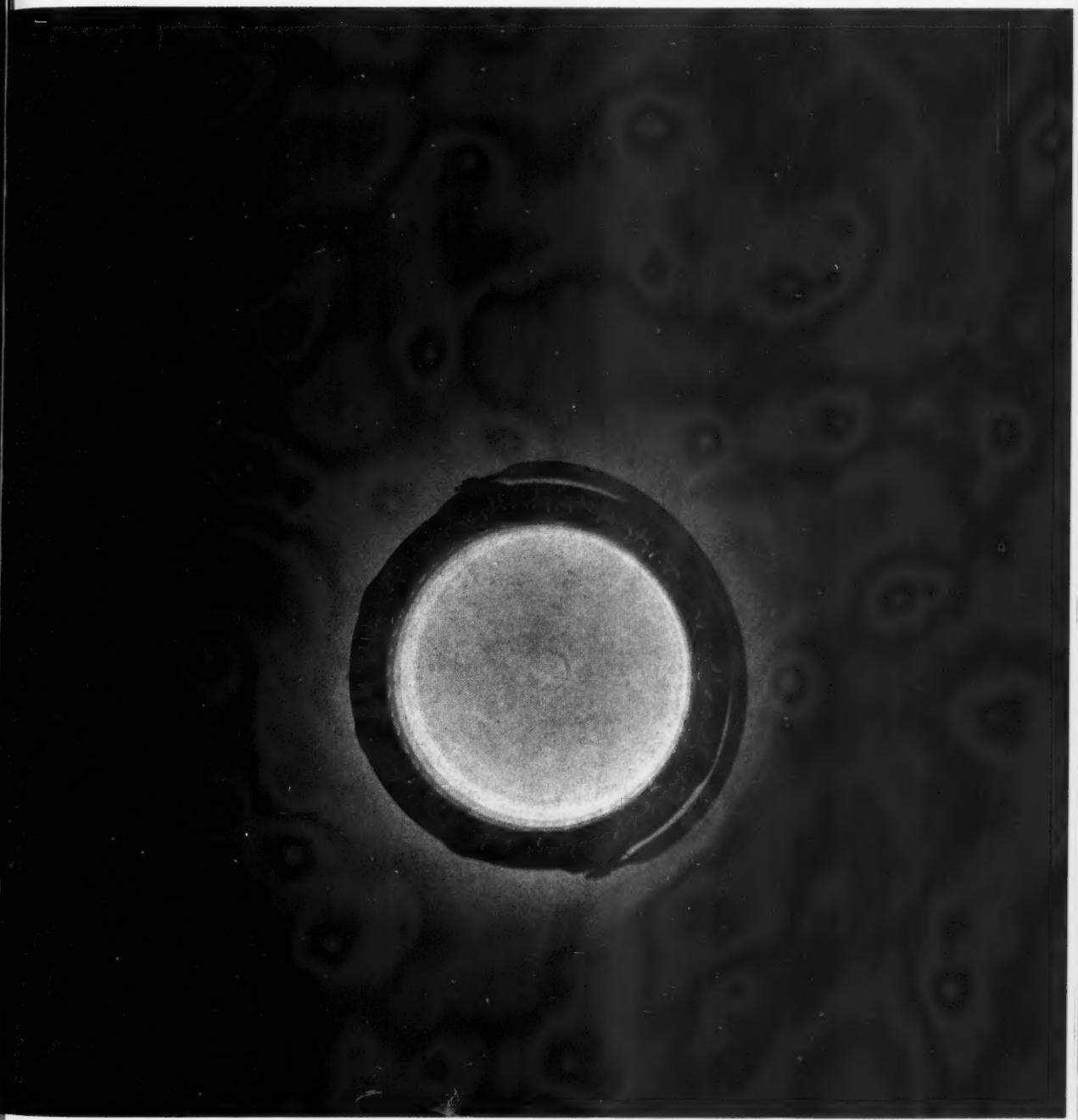
Astronautics

A PUBLICATION OF THE AMERICAN ROCKET SOCIETY

FEBRUARY 1958



A SOVIET BIOLOGIST LOOKS AT LIFE IN SPUTNIK

Society and Space Exploration..... *Donald N. Michael*
Reliability of Complex Equipment..... *Robert Lusser*
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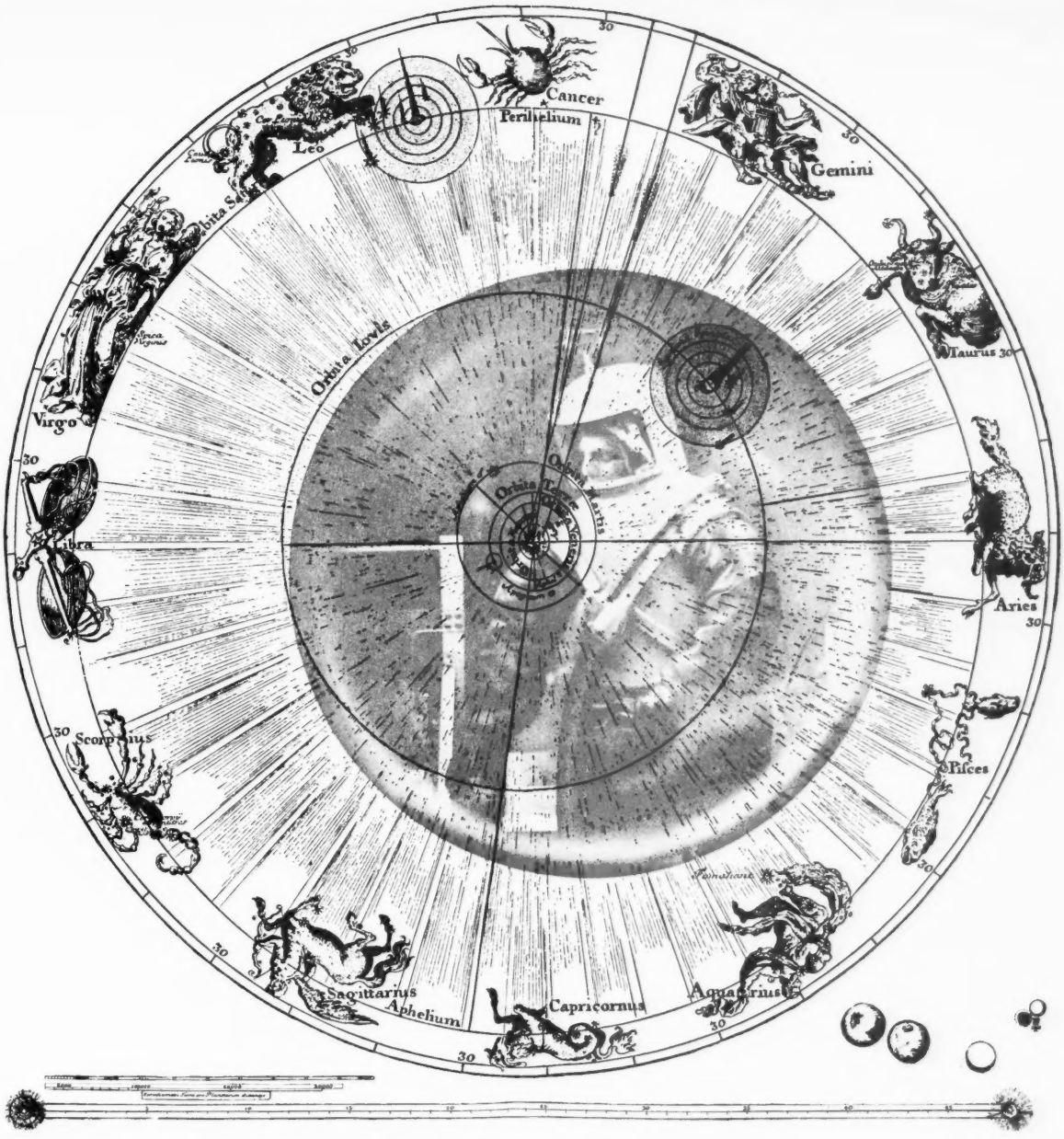

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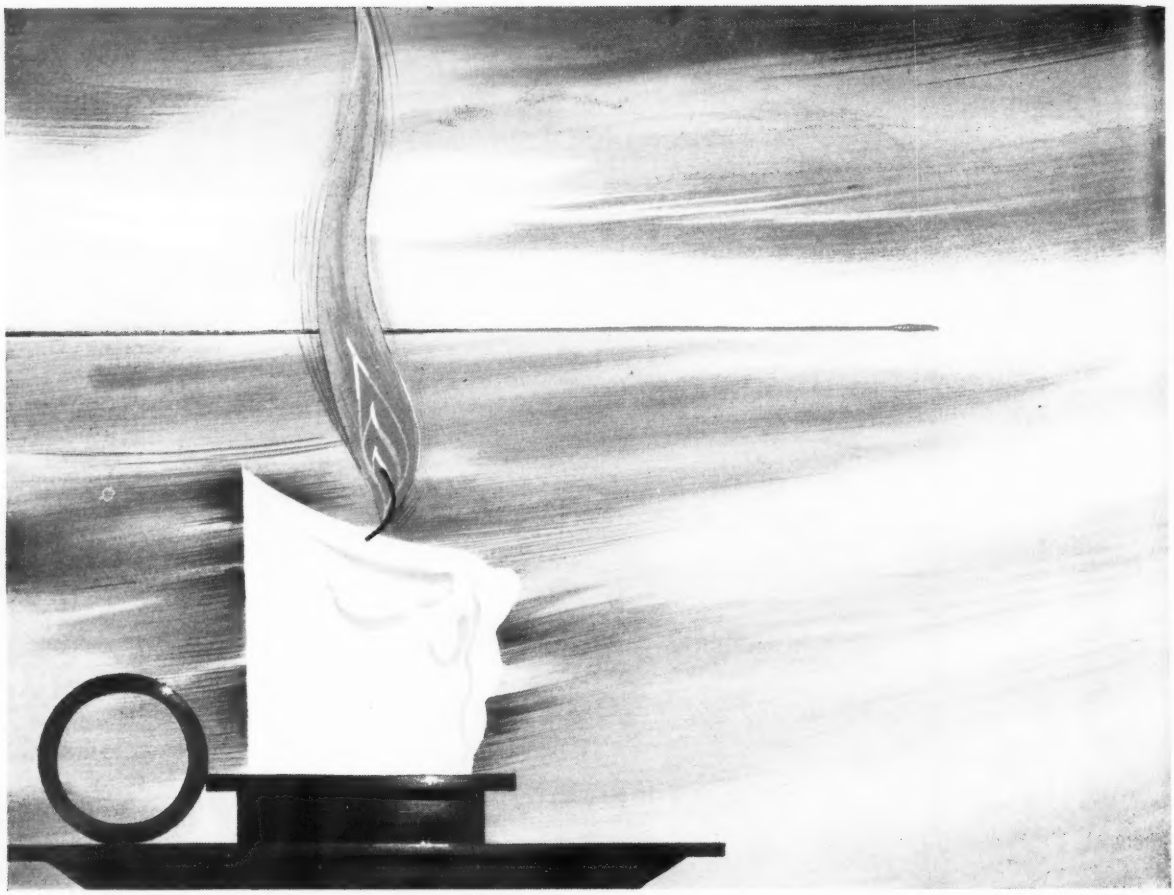

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Astronautics

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February 1958 volume 3 number 2

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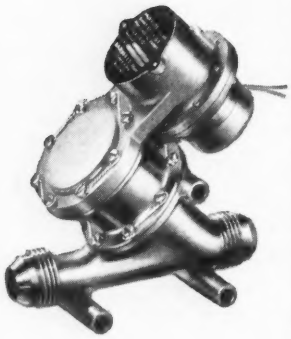

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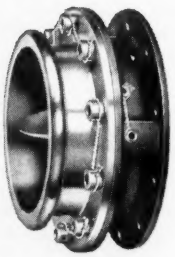

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at press time

Up-to-the-minute news about the rocket, guided missile and jet propulsion fields

MISSILES

• DOD directive authorizing the Army to develop a solid propellant missile to replace the Redstone is seen as first step toward eliminating 200-mile limit on Army missile systems laid down under Wilson "Roles and Missions" ruling. The new missile is expected to have a range of at least 500 miles.

Meanwhile, at Douglas, a solid propellant version of the Thor IRBM is in the works although it is still estimated about three years away.

• Speed-up in missile program may mean earlier test for AF Titan ICBM. Originally set for October, test of Martin missile may be moved up to May or June. A static test stand for the vehicle was recently completed at Martin's Denver plant.

• Canada has dropped its program of R&D work on ballistic missiles to concentrate on an accelerated study of a defense against such missiles. The Canadian Defense Research Board is working on the problem in cooperation with the U. S. and U. K.

SPACE FLIGHT

• NACA has established a special committee on space technology, to be headed by H. Guyford Stever, associate dean of engineering at MIT, to assist in coordinating and bringing into sharper focus NACA efforts in the field of flight beyond the earth's atmosphere. Make-up of the 15-man committee will be announced shortly.

• Efforts will be made to launch a satellite considerably heavier than the 21-lb Vanguard "moon" before the end of this year. A military vehicle—either Thor or Jupiter, with Atlas also a possibility—will be used in the attempt.

• More and more professional and engineering societies are showing an interest in space flight. Latest example: The Telemetry and Remote Control Group of IRE is co-sponsoring a meeting on "Space Electronics" in Miami, Fla., Sept. 22–24. The group is also considering changing its name to "Missile Electronics and Engineering" or "Astronautical Electronics and Engineering."

• Space flight proposals continue to pour into Defense Dept. offices from all sides. AF alone has reportedly received almost 300 such proposals since last October. Meanwhile, Wright ADC scientists recently completed a nationwide tour to investigate projects in this area.

• That U.S.S.R. has at least won a psychological victory in space flight was evident from willingness of Western world to believe unconfirmed report of successful firing of manned rocket. Even Russians expressed surprise over credence given rumors apparently based on Moscow science fiction broadcast.

DEFENSE DEPT.

• Criticism of Defense Secretary Neil McElroy's "single manager" proposal continues to mount. McElroy is being urged to assign responsibility for specific tasks to each service, then insure proper coordination through the Joint Secretaries. Arguments are also heard against putting AICBM and space programs in one organization, since it's generally agreed that they have little in common. However, there is universal agreement that some sort of action is needed, especially with Army-AF rivalry over AICBM's growing day by day.

• Radical changes in the defense organization are unlikely despite the President's known anger at interservice bickering, Capitol Hill criticism and the stimulating suggestions of the Rockefeller report. Key legislators see no need for basic revision of the Unification Act and won't move unless the Administration pushes hard. It's unlikely that important changes will be proposed, for fear of rocking the boat.

BUDGET

• Missile spending will spurt in fiscal '59 budget. Of $39.8 billion in defense expenditures, missiles will acount for $3.3 billion, up $400 million over this year. In contrast, aircraft procurement is off from $7.5 billion to $6.9 billion. New obligational authority for missiles zooms from $2.3 billion to $3.8 billion.

R&D expenditures will rise from $1.8 billion to $2.1 billion, with new authority in this category upped from $1.7 billion last year to $2.2 billion. The new Advanced Research Projects Agency will spend $194 million in fiscal '59, about $5 million between now and June 30. A total of $350 million is sought in obligational authority for the agency.

• Congressional leaders generally feel military budget doesn't go far enough, fails to show sense of urgency, but are inclined to go along with assurances this is the most that can be used effectively at this time. Spending is actually less than $1 billion over fiscal '58, and most of this will be taken up by proposed pay increases. Actually, there is only about $300 million in funds for additional hardware.

• Anticipated rush in defense spending is not expected to materialize. However, after slowing almost to a stop, new orders will come from Pentagon in an increasing stream. Until June, new orders will be substantial; for following year, they will continue at rate sufficient to keep industrial backlogs at a high level.

NUCLEAR PROPULSION

• Despite bearish attitude in some quarters, AEC continues to see important possibilities—perhaps for space flight—in "Project Rover," the effort to develop a nuclear rocket. More funds are being sought for the job, on which some speed-up is considered possible, and plans are already being made for test facilities in the Nevada atomic test area.

• A touch of interservice rivalry entered the nuclear propulsion picture when the Navy proposed to DOD that the first nuclear aircraft be a seaplane. Decision is due shortly on whether to build a new plane specifically designed for nuclear power or install a nuclear reactor in an existing plane, as well as on whether to make the plane a land-based AF plane or a Navy seaplane.

EDUCATION

• Education will be the main topic of discussion at the National Society of Professional Engineers meeting this month at Michigan State University. Theme for the meeting is "Sputnik and the Engineering Profession."

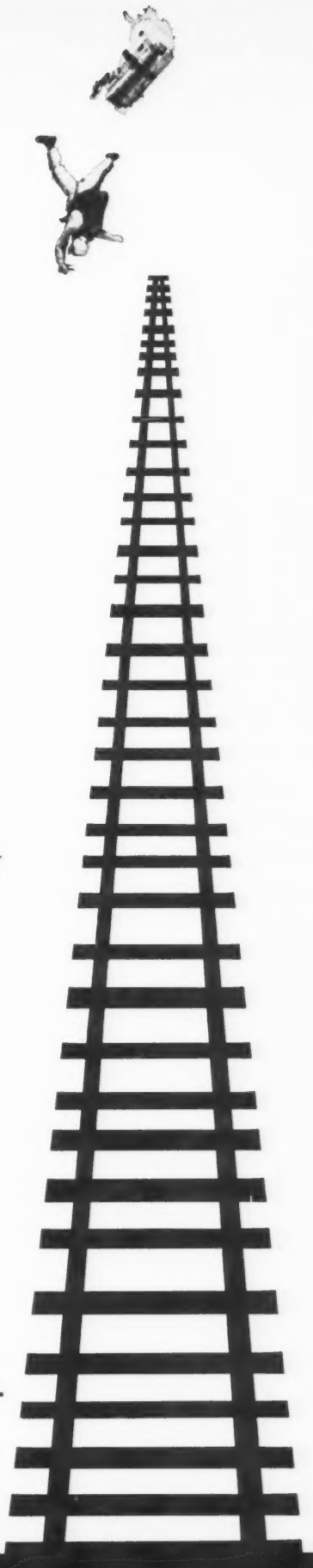
• The President's Committee on Scientists and Engineers is also slated to discuss ways and means of attracting more young people to the engineering professions at a special meeting at Yale University early this month.

ROUNDUP

• North American's X-15, unlike its F-108 long-range interceptor and WS-110A chemical bomber, will not provide a capsule ejection seat for the pilot. Seat of this type is regarded as unfeasible for use at high Mach numbers the ship will reach.

• Nike-Asp rocket reached 105 miles in last shot of Project Sunflare (see page 44). This was first firing of Asp with Nike booster, since 14 previous firings had used Nike-Deacon combination. The 105-mile altitude is reportedly a new record for small two-stage research rockets.

• Phillips Petroleum and North American Aviation have announced the formation of a new company called Astrodyne, Inc., in the solid propellant field. The company, to be jointly owned by Phillips and NAA, will make its headquarters at AF Plant 66, McGregor, Tex., a Phillips plant, and will engage in R&D work and manufacture of high energy solid fuels, propellants and devices for rockets and missile systems.



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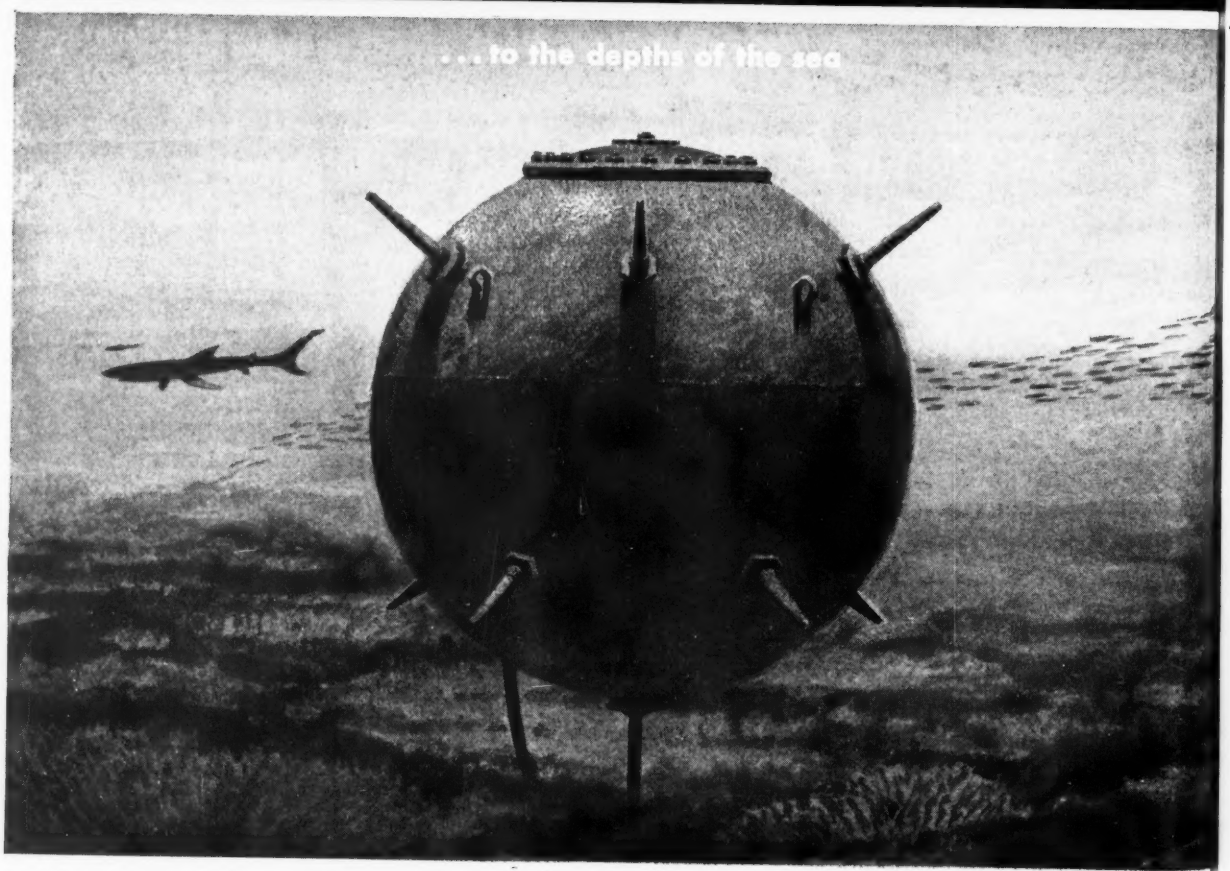

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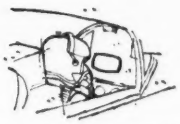

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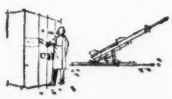

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Soviet Education for Science and Technology by Alexander G. Korol, co-published by the Technology Press of M.I.T. and John Wiley & Sons, New York, 1957, 513 pp. $8.50.

Here is a book which does not deal with rockets, missiles or space flight, but which nonetheless deserves the careful attention of every ARS member, as well as that of every thinking American.

Alexander Korol's thoroughgoing and exhaustive analysis of Soviet scientific and technical education could not be more timely, coming, as it does, on the heels of outstanding Soviet accomplishments in a number of different fields of science. It helps explain how the U.S.S.R. is turning out the thousands of engineers, scientists and technicians who, in the space of a few short years, have managed to steal the mantle of scientific leadership from their American co-equals.

As the author points out, one of the most impressive things about Soviet education today is the vast amount of science and mathematics crammed into primary and secondary school courses. In addition, every effort is made to see that promising students have the opportunity to receive a higher education, since the college and professional education of such students is subsidized by the state.

Equally important is the much greater incentive that exists in Russia for a career in engineering or science. Korol notes that scientists and engineers in the U.S.S.R. not only have stepped into the big money class, but also occupy a leading position in the country's social hierarchy.

Korol is under no delusions about the Soviet educational system. While his careful analysis of education at all levels in the U.S.S.R. indicates to what extent Red leaders have interested themselves in the problem and clearly demonstrates the great progress that has been made, he is not blind to defects in the system.

Thus he points to the fact that too much emphasis is placed on cramming of facts and not enough on basic research, that higher education is inclined to be vocational, rather than professional, and that the humanities are to a large degree overlooked. He also notes the unevenness of education in various parts of the country, the heavy loads teachers must bear and the low wages paid primary and secondary school teachers.

Nevertheless, as he points out in the last chapter, the tremendous emphasis on engineering training has achieved its purpose. He uses the word "training" deliberately, for, as he is careful to note, it is training for a specific purpose, rather than education as we understand it, that the many fledgling engineers and scientists in the U.S.S.R. get.

The framework of the system, he declares, is designed to assure the fact that the most able people go into science and engineering and that the work they do once their training has been completed helps in achieving primary Soviet aims, particularly, strengthening of the state.

The author's summing up, in the last paragraph of the book, puts the problem in a nutshell. To meet the Soviet challenge, he declares, we must forget about "business as usual," in education as well as in other fields, and face up to the fact that our national survival depends on the understanding that certain goals must take precedence over the more material objectives which seem to absorb us to such a degree today. As Korol puts it:

"If, in the face of the Soviets' superior power to allocate the resources under their control, democracy and economic progress for all nations are to prevail . . . we free peoples must find a way to release a larger share of our aggregate resources and energy from nonessential material uses and devote them to the service of indispensable goals." —I.H.

The Space Encyclopaedia, a Guide to Astronomy and Space Research, E. P. Dutton & Co., New York, 1957, 287 + 5 pp, over 300 illustrations. $6.95.

The worth of an encyclopedia (we'll stick to the American spelling, if you don't mind) depends on many things —the purpose it's designed to serve, who does the editing and, most important of all, who the contributors are.

The Space Encyclopedia is proud of its contributors, and with good reason. Once it was decided to publish a handy reference of this type, it was obviously also decided to make it as good a reference as possible by getting top people in the field it covered to contribute to it.

This the editors have done, with the result that contributors include such well-known authorities as British astronomers Sir Harold Spencer Jones and A. C. B. Lovell, Hubertus Strughold, Homer E. Newell and Eric Burgess, among many others.

The editors have gone even further. Rather than restrict contributors to encapsulated entries on items of major importance, they have permitted them to write short essays on the more important subjects, and have even seen to it that these essays are initialed by the contributor who wrote it.

Thus, Dr. Strughold contributes a pithy outline of space medicine, Dr. Newell an excellent analysis of artificial earth satellites and Burgess short introductions to rocketry and guided missiles.

The book is just what its name implies—a popular and factual guide not only to rocketry, missiles, upper-atmosphere research and space flight, but to all branches of astronomy as well. As a matter of fact, since astronomers make up half of its list of contributors, reading only those entries relating to astronomy would provide one with a pretty good background in the field.

The subjects literally range from A to Z (the A-4 to Zone Time), and pretty well cover almost everything that lies in between. Alongside a brief description of a crab nebula, for example, you'll find entries on creep and critical angle; next to an explanation of orbital refueling, a rundown on Orion; immediately below static firing, items on Stefan's Law and stellar energy.

Any criticism of the book, which represents the first attempt to compile a handy reference work of this type, must be regarded as unkind, but a word should be said about the illustrations. While most of the maps, charts and drawings are excellent, the quality of the photographs, many of which have been reproduced from other publications, is not all it should be. Balanced against this, however, is the fact that there are so many illustrations—well over 300 in a book of less than 300 pages.

Every effort has been made to keep the book factual, as well as up to the minute. A November, 1957, supplement, for example, provides information on Sputnik I, the Farside project and 1957 comets.

All in all, the editors, contributors and publisher of The Space Encyclopedia deserve an A for effort and no worse than B+ for accomplishment. The book is worthy of a place on the reference shelf of anyone with an interest in space. —I.H.

(CONTINUED ON PAGE 95)

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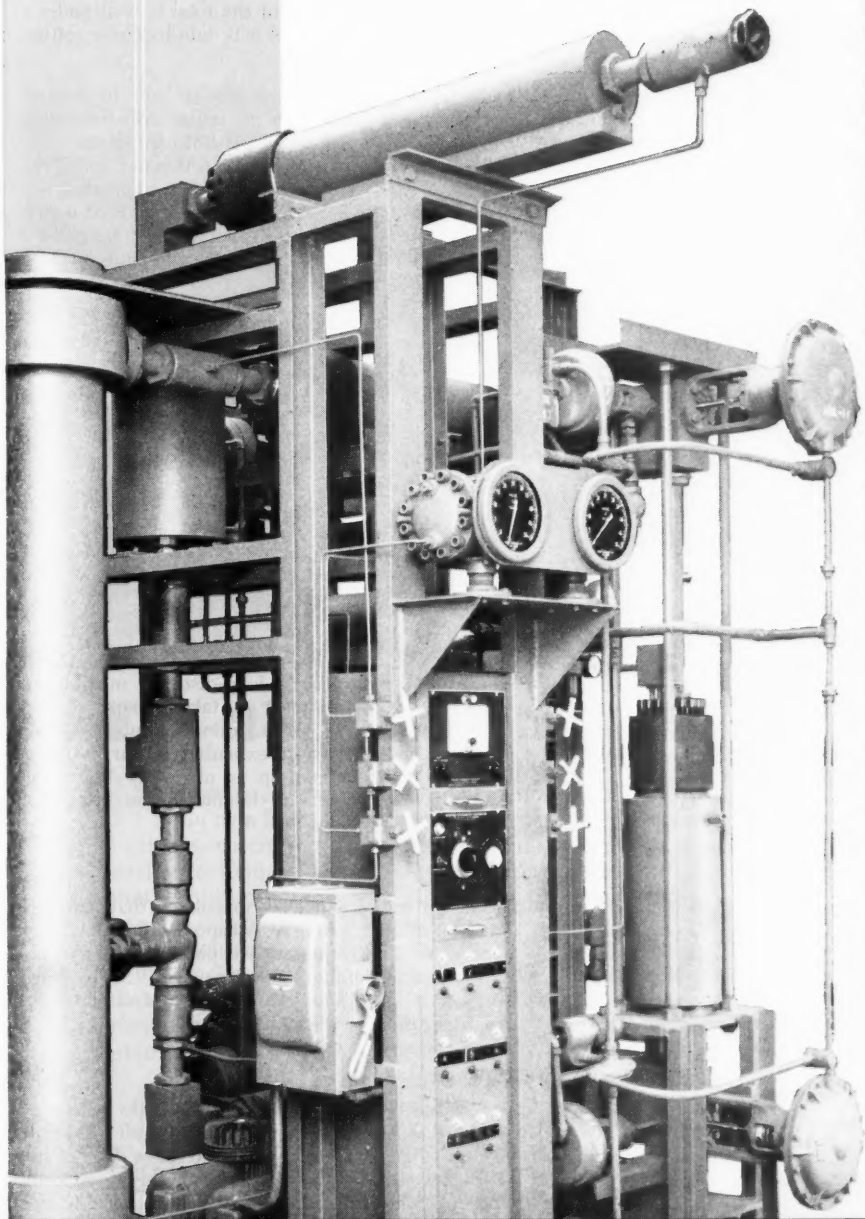

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News highlights from Washington

SPACE FLIGHT

• An independent space agency, such as recommended in the ARS Space Flight Program, is not likely to emerge from current Washington discussions of defense organization. While many officials sympathize with the broad objectives set forth in the ARS report, the consensus seems to be that rockets, satellites and space programs are wedded to the defense establishment—for better or worse—for quite a while to come.

Post-mortem regrets that Vanguard was divorced from military programs contribute to this attitude. So does the hard fact that too many people and organizations have already staked out claims in the space field, and won't let go short of legislation or a direct order from the White House. Neither is likely.

Although the nonmilitary potentialities of space vehicles are recognized, Washington's attention is now focused on the defense problem, and space problems are viewed almost exclusively in this light. Desirable as the concept is, an independent space agency in the near future would in all probability find itself playing a Cinderella role, bypassed administratively and frustrated financially.

• Privately, a few officials have discussed the possibility of returning all regular Army missile work to the basic Redstone Arsenal organization and making ABMA a unified DOD agency which would be turned loose on space programs. Although ABMA is ideally staffed and equipped for such a mission, this is only a very long-shot possibility.

BUDGET

• The billion-dollar supplemental for this fiscal year represents some fancy budget juggling. It's really an early 1959 appropriation, and comprises items that originally were in next year's program. When the so-called supplemental was decided upon, requests for fiscal 1959 were cut back accordingly—a partial explanation for the modest step-up from this year to next. Although welcoming an earlier start on some programs, many Pentagon officials are privately disgruntled at what they consider Administration's failure to accelerate as rapidly as possible and necessary.

• AF will consume just under half of the $40 billion to be spent on defense in fiscal 1959. Missile expenditures, highest ever, will help depress number of aircraft purchased to lowest point since the Korean war. Thor, Atlas and Titan spending will rise substantially, but construction of ICBM bases in the U. S. will move slowly (only one in the new budget), both for economy reasons and because AF is cautious pending final development of its ICBM's.

IRBM's

• Despite signing of $30 million contract with Chrysler to produce Jupiter missiles, Pentagon insiders believe choice between Army IRBM and AF Thor is inevitable and may come later this year. Except by those who made it, the decision to buy both missiles is criticized bitterly behind the scenes in Pentagon. It means, critics say, fewer weapons for the same dollars and no real speed up in operational availability. Particularly in view of quantities being ordered, ridiculously small in light of all the missile talk at the Paris NATO meeting, many insiders think the Thor-Jupiter decision was made in the post-Sputnik panic and will be regretted.

• The number of Thor and Jupiter squadrons being planned is secret, but the total is well under a dozen, making reports of a Britain-to-Turkey string of bases sound silly.

• Army appears to have lost its bid to operate Jupiter with its own men, under AF command. Instead, AF is organizing IRBM squadrons (two announced so far) and will train them at both Redstone Arsenal and Camp Cooke, depending on whether unit is to use Jupiter or Thor. First operational unit is now definitely slated for assignment to Britain by the end of this year. Odds favor it being a Thor squadron.

• Polaris program is now being pushed very hard. Work on special pad is being rushed at Cape Canaveral and test program will get into high gear this Spring. There's also new push behind plans for submarines to carry the weapon. Money in fiscal 1958 supplemental will permit ordering three nuclear-powered missile subs in near future. Most likely design calls for 16 missiles per vessel, carried near-vertically in individual firing tubes.

Polaris is also destined for service aboard aircraft carriers. It will probably replace dual-purpose guns now emplaced in pods outboard of the flight deck.

NEW TEST RANGE

• Definite plans for a long-distance missile test range on the West Coast are taking shape. Camp Cooke, Calif., AF missile training center, will be firing point, with range extending as far as Bikini for ICBM tests. Set-up is obviously being designed with problem of familiarization firings for ICBM units in mind.

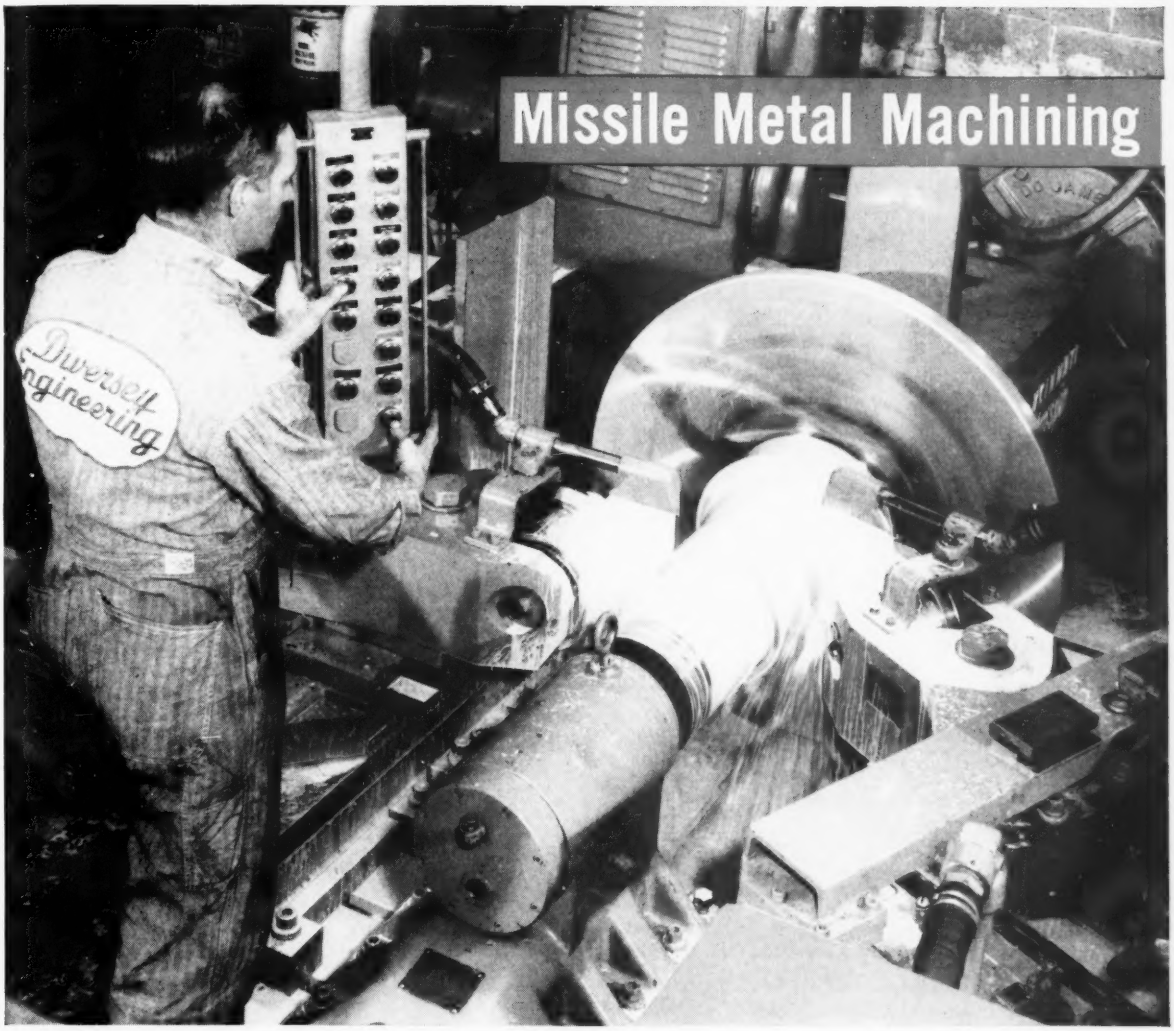
SATELLITES

• A top military official speculates that satellites will be a major offensive weapon within 10 years, and that an anti-satellite weapons system will become feasible at about the same time. So far, however, Pentagon emphasis is on use of satellites for reconnaissance, rather than offense.

ICBM's

• AF sources say it'll be several months before an attempt will be made to fire Atlas its full 5500-mile range. Recent flight of only 600 miles did not use full power but was considered highly successful. It's now probable that Atlas will be used to loft good-sized satellite by early 1959.

• First firing of Martin's Titan ICBM is slated late this year.



NEW HYDROSPINNING AT DIVERSEY

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for the record

The month's news in review

Dec. 10–AF creates a Directorate of Astronautics to organize and manage work on anti-missile missiles, reconnaissance satellites and other space weapons.

Dec. 12–A group of 27 prominent scientists proposes creation of civilian-controlled National Space Agency with $1 billion a year budget for next 10 years.

–AF F-101A Voodoo jet fighter-bomber sets new world speed record of 1207.6 mph.

–Defense Dept. plans to step up missile spending, now about $2.9 billion a year, by 50 per cent during fiscal 1959.

Dec. 13–AF suspends plans for creating a Directorate of Astronautics on request of Defense Dept.

–Explosion at Thiokol's Elkton (Md.) solid propellant plant kills four people and injures four others.

–AF says it will build $12 million Snark Site at Presque Isle (Me.) AF Base.

Dec. 14–Moscow news reports Russia has a number of projects under way to place a satellite in orbit around the moon.

–Maj. Gen. John Medaris, ABMA Commander, tells Senate subcommitte U. S. needs million-pound thrust engine to stay in space race.

Dec. 16–Convair's J. R. Dempsey says he thinks Atlas will be used to launch a large satellite.

–AF rescinds its ban on space talk, issued July 29.

Dec. 17–National Aeronautic Assn. awards 1957 Wright Brothers Memorial Trophy to Sen. Stuart Symington, first Secretary of the Air Force.

–After two earlier unsuccessful tests, Air Force successfully fires its Atlas ICBM.

–AF Secretary Douglas tells Senate subcommittee Atlas will be operational within two years and that, with a booster now in existence, it could carry a 1000-lb satellite into orbit.

–First Snark group of 105 airmen finish training at Northrop. The group will be assigned to first operational SAC long-range missile squadron.

Dec. 18–Technical difficulties prevent Army Jupiter from successfully completing a flight test.

–NATO nations agree in principle to U. S. proposal to deploy IRBM's in Western Europe. Missiles are expected to be ready for delivery to Britain by the end of this year.

–Rocket scientists are conspicuous by their absence on list of 922 Soviet citizens cited for outstanding technical achievements in 1957.

Dec. 19–Northrop discloses it has designs for supersonic version of Snark, using advanced jet engines now under development.

–AF successfully fires another Thor.

Dec. 20–President of Soviet Academy of Sciences warns against overestimating Russian scientific achievements, says "great efforts" are needed before U.S.S.R. can claim to have overtaken U. S. in all branches of science, as Soviet legislature ups budget for scientific development to $1.8 billion, 10 per cent more than last year.

–Defense Secretary Neil McElroy says Congress will be asked for supplementary appropriation of an additional $1 billion for missile development in fiscal year ending June 30.

–AF discloses plans to tighten security curtain around Cape Canaveral.

–Gaither report, excerpts from which had leaked to press, stirs storm in Capital.

Dec. 21–NACA Executive Director John F. Victory warns against delay in increasing salaries of government research scientists.

Dec. 23–AF awards contract to North American for WS-110A 2000 mph "chemical" bomber.

Dec. 24–Russia announces successful test of new jet bomber for which nonstop distance record without refueling is claimed.

Dec. 25–AF shows interest in land-based version of Navy's solid fuel Polaris IRBM.

Dec. 26–Aircraft Industries Assn. sees missiles making up 35 per cent of aviation sales by the end of this year.

Dec. 27–Administration considers creation of special Presidential emergency fund of $500 million to exploit promising developments in missile or satellite technology.

–Pentagon figures show more than $17 billion has gone into missile research development and production since WW II, with all but $500 million programmed since beginning of Korean War.

Dec. 28–White House takes exception to published stories that Gaither report had found U. S. in state of peril or said the country "at this time" is weak in relation to the U.S.S.R.

Dec. 29–Defense Dept. decides to carry out future satellite launching attempts in secrecy.

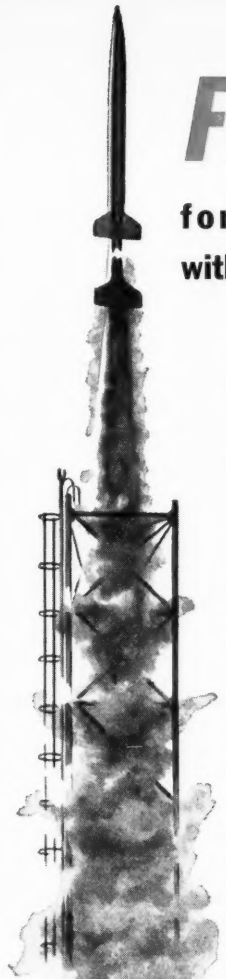
Dec. 30–Moonwatch headquarters at Cambridge, Mass., begins death watch for Sputnik I as Soviet and American scientists agree the satellite will burn up some time early in January.

–Administration announces emergency program for American education calling for $1 billion outlay over next four years.

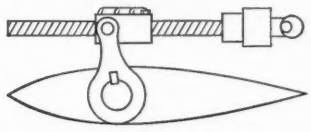
–First Bomarc missile comes off Boeing production line.

FAIL-SAFE ACTUATION

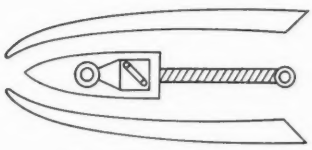
for guidance and control in difficult environments with SAGINAW b/b SCREWS and b/b SPLINES



TYPICAL APPLICATIONS

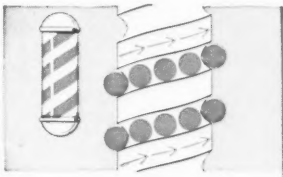


Control surface actuators

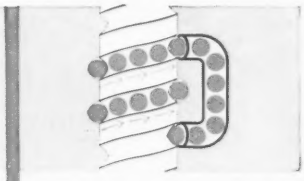


Nose cone positioners

Evelon positioners • Afterburner controls • Speed brake actuators • Rocket engine displacement actuators • Clamping mechanisms for missile boosters • Fuel controls (3-dimensional cams) • Black box tuning devices—telemetering and guidance systems • Antenna coupler tuning mechanisms



Nut *glides* on steel balls. Like stripes on a barber pole, the balls travel toward end of nut through spiral "tunnel" formed by concave threads in both screw and mating nut.



At end of trip, one or more tubular guides lead balls diagonally back across outside of nut to starting point, forming closed circuit through which balls recirculate.

1 VITAL POWER SAVINGS. With guaranteed efficiency of 90%, Saginaw b/b Screws are up to 5 times as efficient as Acme screws, require only ⅕ as much torque. This permits much smaller motors with far less drain on the electrical system. Circuitry is greatly simplified.

2 SPACE/WEIGHT REDUCTION. Saginaw b/b Screws permit use of smaller motors and gear boxes; eliminate pumps, accumulators and piping required by hydraulics. In addition, Saginaw b/b Screws themselves are smaller and lighter. Units have been engineered from 1½ in. to 39½ ft. in length.

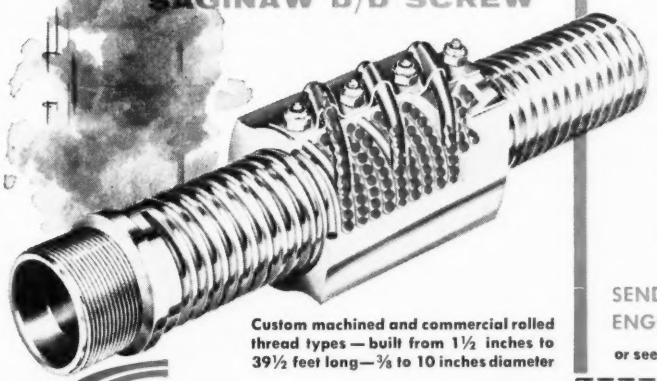
3 PRECISE POSITIONING. Machine-ground Saginaw b/b Screws offer a great advantage over hydraulics or pneumatics because a component can be positioned at a predetermined point with precision. Tolerances on position are held within .0006 in./ft. of travel.

4 TEMPERATURE TOLERANCE. Normal operating range is from −75° to +275° F., but assemblies have been designed in selected materials which function efficiently as high as +900° F. These units are practical where hydraulic fluids have lost efficiency or reached their flash point.

5 LUBRICATION LATITUDE. Even if lubrication fails or cannot originally be provided because of extreme temperatures or other problems, Saginaw b/b Screws will still operate with remarkable efficiency. Saginaw units have been designed, built and qualified for operation without any lubrication.

6 FAIL-SAFE PERFORMANCE. Far less vulnerable than hydraulics. In addition, Saginaw offers three significant advantages over other makes: (1) Gothic arch grooves eliminate dirt sensitivity, increase ball life; (2) yoke deflectors and (3) multiple circuits provide added assurance against operating failure.

SAGINAW b/b SCREW



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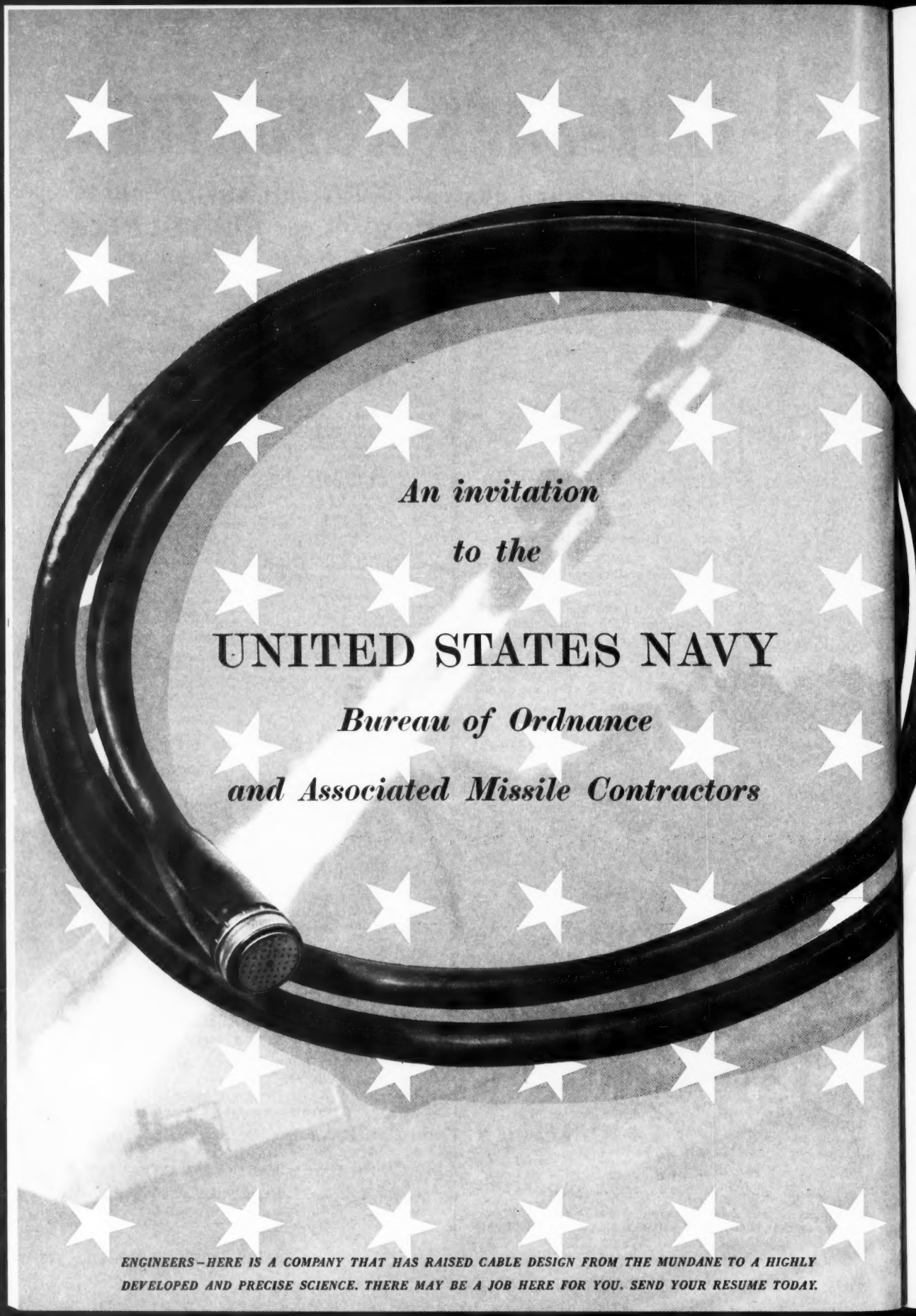
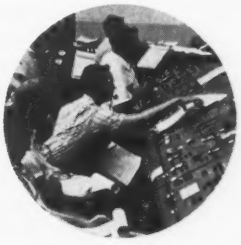

An invitation
to the
UNITED STATES NAVY
Bureau of Ordnance
and Associated Missile Contractors
ENGINEERS – HERE IS A COMPANY THAT HAS RAISED CABLE DESIGN FROM THE MUNDANE TO A HIGHLY DEVELOPED AND PRECISE SCIENCE. THERE MAY BE A JOB HERE FOR YOU. SEND YOUR RESUME TODAY.

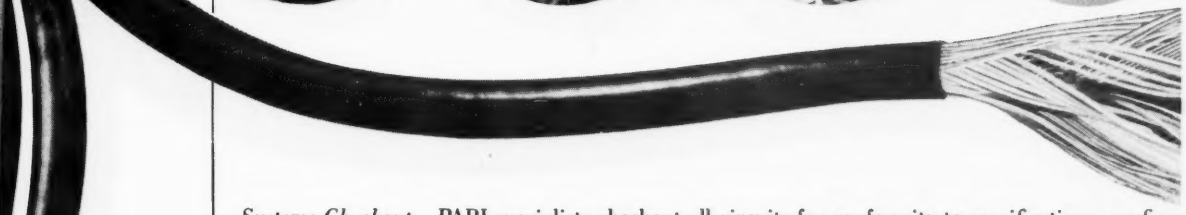
INVITATION:

This is an invitation to utilize the missile systems engineering services of Pacific Automation Products, Inc., on current and upcoming Navy missile programs.

SPECIFIC SERVICES:

PAPI offers the following services in the cabling and activation of missile test and launch facilities: *Systems Design* – working from schematics, PAPI design engineers will determine every conductor that is needed to link block houses, control centers, terminal rooms, and stands or platforms. Cables are designed to effectively accommodate these conductors, and include break outs, connectors, and accessories. *Systems Fabrication* – cable assemblies leave our plant in ready-to-install condition, with rigorous quality control procedures governing every step of the fabrication process. *Systems Installation* – PAPI's experienced personnel and proven methods are utilized in field installation of all inter-unit cabling, instrumentation, recorders, transducers, controls, consoles, and accessories.





Systems Checkout – PAPI specialists checkout all circuits for conformity to specifications, confirm the operation of each instrumentation system, and validate the fire and launch control functions. *Systems Documentation* – working drawings of the entire installation are supplied in approved form.

QUALIFICATIONS:

PAPI is an efficient organization of 600 persons. 130,000 square feet of floor space house engineering and production capacity to meet any workload. Because PAPI cable components have been used in Navy projects, including Vanguard and the Regulus missiles, you know our product to be reliable.

PAPI systems engineering services have been used on other missile programs with these results:

- ▶ All sites and facilities are being completed on or ahead of schedule.
- ▶ 16,000 cable components are now in service, with no malfunctions due to cabling.
- ▶ Costs have been far less than predicted.
- ▶ Superior designs and simplified operational characteristics have marked each facility.

Of special interest will be PAPI's Water Tight cable, which salt water cannot penetrate at 500 fathoms. It is ideal for underwater umbilicals.

Because the mechanical and environmental capabilities of PAPI cables often permit great simplification in the design of missile facilities and savings in cost, an early visit by PAPI with site or facility builders is recommended.

CONCLUSION:

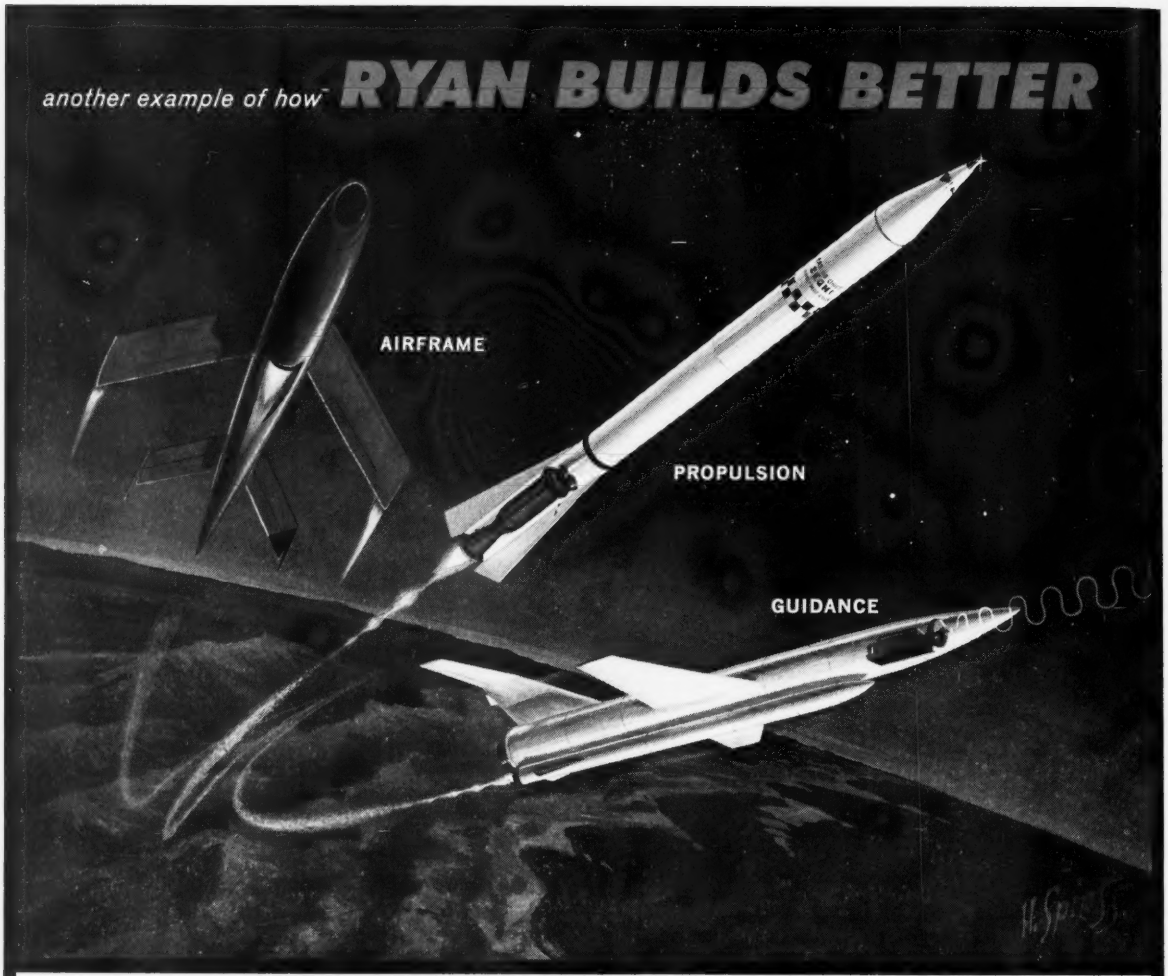
PAPI's engineering staff includes men with outstanding experience in every phase of the missile business. It is no accident, therefore, that we are the "take charge" sort of people who can take full responsibility for providing the services described in this message. We hope that you will accept this invitation and plan to utilize PAPI's great practical knowledge and experience in missile facility cabling and activation.

Arthur P. Jacob

ARTHUR P. JACOB, EXECUTIVE VICE PRESIDENT

PACIFIC AUTOMATION PRODUCTS, INC.

1000 AIRWAY, GLENDALE 1, CALIFORNIA *Phone: CHapman 5-6871 or CItrus 4-8677*



UNDER ONE ROOF: FRAME, BRAIN AND MUSCLE FOR A MISSILE

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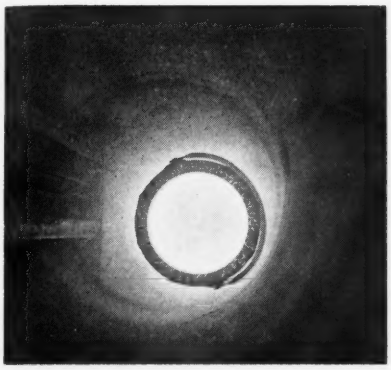


COVER: *"Radiological hot cell" at Wright Air Development Center. 23,000-curie cobalt-60 source was photographed from camera looking down 17-ft well filled with water. Source sits at bottom of well* (*see page 31*).

Astronautics

FEBRUARY 1958

Students and the American Rocket Society

Let me tell you briefly what the AMERICAN ROCKET SOCIETY is doing or planning to do to arouse the interest of young people and help educate them in the principles of the technical subjects our activities cover.

For many years, we have encouraged college students to participate in the activities of our Society. To make it easier for young people to join ARS, we have set student membership dues at a point well below the cost of their membership to the Society. I believe that the resulting financial deficit has been well repaid by the scientific stimulus provided. Response has been excellent, and student membership has increased by 50 per cent during the last year. We now have seven student chapters at recognized colleges and universities, and more are being formed.

Two months ago, the Society held a very successful Student Conference in New York; another is planned in June. For the past nine years, we have asked students to submit technical papers in a nationwide competition. The Society, with the help of Chrysler Corp., gives a medal and $1000 to the winner.

The Society also intends to provide the impetus for an improved national program for scientific education, particularly in the fields of rocketry, jet propulsion and astronautics. As a step toward this goal, the Training and Education Subcommittee of the ARS Space Flight Committee has initiated a survey of colleges and universities to ascertain exactly what courses are being offered at both the graduate and undergraduate levels. Preliminary results of the survey indicate that tremendous voids exist in this area—voids which must be filled.

In addition, a new ARS program, to be announced shortly, is designed to channel the interest of high school students toward the fields of rocketry, jet propulsion and astronautics. It is felt that this objective can best be accomplished through classes, directed studies, individual and group projects, and exhibits.

The education and orientation of American youth toward scientific careers are matters in which each of us can play a part. I cannot urge you strongly enough to talk to young people and explain to them what we are doing and why. We must not only impart information to these youngsters, but also infect them with the same fascination with technical problems that has enabled many of us to carry on through the formative years of a great new field.

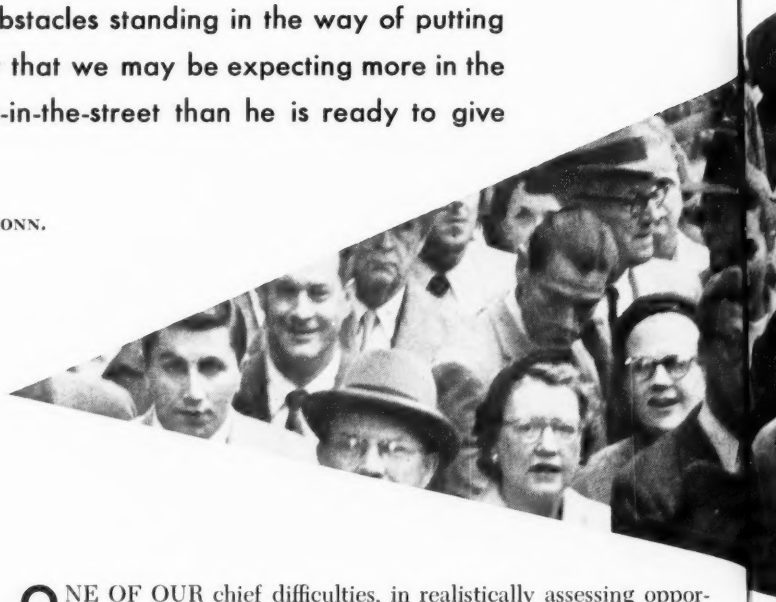
George P. Sutton
President, AMERICAN ROCKET SOCIETY

Society and space exploration

A psychologist examines the obstacles standing in the way of putting a man in space and points out that we may be expecting more in the way of support from the man-in-the-street than he is ready to give

By Donald N. Michael

DUNLAP & ASSOCIATES, INC., STAMFORD, CONN.



Donald Michael is a rather unusual combination of social psychologist and physicist. In 1944–46, he was an electronics engineer with the Army Signal Corps, where he worked on the development of radar and communications equipment. In 1953–54, he was staff social scientist for the Weapons System Evaluation Group of the Joint Chiefs of Staff, and since 1953 he has been a consultant to many government agencies on problems pertaining to the impact of technological developments on human behavior. He is also an advisor to the National Science Foundation on survey methods and research for attitude and motivation studies on national science policy. Dr. Michael is now senior research associate, Dunlap & Associates, specialists in man-machine system analysis. The views expressed in this article are those of Dr. Michael and do not necessarily reflect those of Dunlap & Associates.

ONE OF OUR chief difficulties, in realistically assessing opportunities and problems with regard to the future of space exploration, is that of restraining our very natural tendency to project our own interests, awareness and sweet reasonableness onto the rest of the population. This is not a tendency in any manner unique to the AMERICAN ROCKET SOCIETY. However, given the sheer excitement of our interests, the commendable but not always realistic tendency of Americans to believe that technology and science hold the answers to all our problems, and the likelihood that those participating in ARS activities are relatively sensitive to many facets of the world picture, it is not unlikely that we may tend to expect more from our fellow humans, in the way of wholehearted support, than they may be ready to give.

Hence it would seem advisable to review briefly a very few circumstances which do now and will in the future comprise the socio-psychological context in which efforts to explore space will evolve. We are all familiar with the optimistic picture which can be painted of this evolution, of its effects on our social structure and of its values, so there is no point in even mentioning them here.

Instead, let's examine some of the social pressures which may cause difficulty in the optimum realization of these enthusiastic predictions—not because I believe they necessarily will come about, but because we should at least be aware of them.

The new concept of the possibilities of the exploration of space, and the creative, and possibly military, imperatives for doing so, comes into the vast matrix of already existing social and psychological values, beliefs and behaviors which define our society today. The concept comes at a time when it may be especially difficult to attain a reasonable and balanced evaluation, since societies are in the process of vast change, ideological and technological.

All this we know in general. But let me remind you of a few factors of special significance for the U. S. Our population is increasing

at a terrifying rate. It is estimated that by 1975 we will have around 225 million citizens. By 2050, the estimates run between 600 and 900 million, with a world population of between 6 and 9 billion. By 1975, one person in 10 in the U. S. will be over 65, with the number increasing steadily thereafter. Also, in 15–20 years, we will become a "have-not" nation in terms of our ability to provide many of our own crucial raw materials, according to the Paley Report and other studies.

Education Is Important

But looming most ominously of all, and transcending any combination of these trends, is the pre-eminent question for a democratic nation: Can we educate our ever-growing population sufficiently to provide people with the capacity to vote and act intelligently in their own interests and in those of the nation and humanity at large? To my mind, the future of space exploration in the U. S., and perhaps everywhere, depends much more on the answer to this question than any other.

Thus, in its social context, man's effort to explore space becomes just one more problem—albeit an exciting one—in allocation of effort, money, prestige, emotional involvement and sheer day-to-day expedience. And, as with these other problems, man-in-space will require a lion's share of money, material, brains and operational planning, as well as the compromising of conflicting interests. For that matter, it will require *stimulating* the kind of interest which pays off in the furtherance of our aspirations for space exploration. Let us, then, examine a bit more closely some of these conflicts of interest and some of the prerequisites for support of space studies.

Funds for research and development and actual operations for the exploration of space come high. To be used efficiently, they must be available continuously and with foreknowledge as to amounts, so that plans may be made and operations effectively phased. Moreover, the costs of these efforts can be expected to increase over the years.

WHAT DO YOU KNOW ABOUT SPACE?

1. Earth is one of nine planets (there are also an estimated 44,000 smaller asteroids) which travel in orbits about the Sun. How many times larger than the Earth is the Sun? (_____ times) How many of the other planets can you name? (_____, _____, _____, _____, _____, _____, _____, _____, _____) On which, if any, of these do scientists think there may be (a) life (_____, _____, _____) (b) Earth-like human life? (_____, _____)

2. Why is it that when we talk about the planets and the Sun and other stars we say that space separates them instead of saying that air separates them? What is the difference between the air and space? (_____)

3. How far away from Earth's surface does space begin? (_____miles) What determines the boundary? (_____)

HOW DID YOU LEARN IT?

1. Indicate the three leading sources of your information about space, numbering them in order with the numeral 1 marking the most important. (a) school_____(b) work_____(c) technical books_____(d) technical journals_____(e) other books_____(f) magazines_____(g) newspapers _____(h) radio_____(i) TV_____(j) your children_____(k) their teachers_____(l) your neighbors_____(m) your friends_____(n) others_____(please specify). Check any of the following who have expressed particular interest and knowledge of the subject: your clergyman_____, physician_____, dentist_____, lawyer_____, clerks in shops and stores_____, policemen_____, bus drivers_____, taxi drivers_____, children_____, others_____ (please specify.)

2. Did you read or hear much about space before Sputnik went up? (Yes_____, No_____)

3. Have you talked to others about Sputnik (more, about the same, less) than about other front page news items? (Please circle the appropriate word.)

4. Have you talked about Sputnik to anyone with whom you usually don't discuss news events? (Yes_____, No_____) If "yes," why? (_____)

WHAT DO YOU THINK ABOUT MAN IN SPACE?

1. Do you personally feel that the effort to put man into space is good (_____) or bad (_____)? (Please check one.) Why?

2. Do you think the efforts to put man into space will have any effect on your own life? If so, what effect?

3. Would you like to be one of the first people to explore space? (Yes_____, No_____) Why?

4. How do you feel about the Russians putting a dog into space? Are you shocked by their willingness to let a helpless animal die alone, or do you believe it is necessary for animals to test whether space is safe for men? What aspect (or aspects) of Sputnik and Muttnik made the deepest impression on you? If you list more than one, put the most important first.

5. What difference do you think it would make to the human race if other life equivalent to human life were found in the universe? Suppose this extraterrestrial life were superior to the human race, then what? When you ponder such questions, do you think (not enough, enough, too much) attention is being paid to scientific research? Do you think (not enough, enough, too much) attention is being paid to research in the humanities?

Part of the questionnaire which the author worked out in a cooperative project with John Lear, Science Editor of *The Saturday Review*. The questions were originally published in the Science Section of *The Saturday Review*, in an attempt to learn the state of mind of its readers in regard to space flight—what they know about it and what the man-in-space concept means to them.

Competing for these sums will be, among others, a growing and vocal segment of our over-65 voting population. There is no reason to believe that the adventures or rewards going to the strong and youthful from space exploration will inspire these elder citizens to place support of government expenditures for space research above expenditures for increased social security, old age insurance and other services which inherently will be more appealing to them.

Also competing for these funds will be the imperious requirements for alleviating the growing complex of urban problems brought on by our rapidly increasing population.

"First Things First" Attitude

My strong suspicion is that urban and suburban dwellers of the near future will be much less interested in putting a man on the moon or Mars than in voting a man into office who will vote funds for *their* pressing needs. Let me suggest, too, that, as people become more and more adjusted to crowded, massive urban life and align their values and aspirations ever more in terms of that kind of life, it may become very difficult for them to be sympathetic to the aspirations and way of life implied by space exploration.

In fact, the unknown of open space, and the unexpected, which space travel must symbolize, may provoke sufficient anxiety to deflect their active interest in this area, thereby restricting their participation to that of spectator sportsmen, who are already so withdrawn from involvement that they prefer to watch games on television rather than go to the arena.

Definite attitudes in this direction toward space exploration may be detected even today. Behind the not infrequent question, "Why would anyone want to go to the moon anyhow?" lies an almost unvoiced fear of the unknown, of "something" which is somehow disrupting to the hard-won and tenuous stability of city living.

Given these competing interests and attitudes, let's examine the sources and nature of support which we might hope to call upon and see whether this support is the kind we can best use, and, if so, to what extent we can count on it.

One major source of support which we have only tacitly referred to and which, from the socio-psychological standpoint, deserves mention, is the military. Let me be perfectly clear that I am well aware that many of the most dedicated and accomplished persons in the area of space research are in the military today and will be there in the future. However, there is no reason to believe that their personal interests will always be compatible with the interests of the military as an (CONTINUED ON PAGE 88)

Aid for basement rocketeers

ARS moves to set up new program designed to eliminate dangerous, unsupervised experiments and assist interested youngsters and amateurs

By Irwin Hersey

EDITOR OF ASTRONAUTICS

"DEAR SIRS," the letter begins. "In the very near future I intend to launch a dry-fuel rocket. . . . The rocket will be fired by remote control from an observation bunker located, say, 50 yd away. The fuel will consist of 75 per cent zinc and 25 per cent sulfur. I have accomplished the problem of stability by adding fins (aluminum) to the copper tube, which is 96 in. tall, has $^1/_{16}$ in. thick walls and is 3 in. in diam. . . .

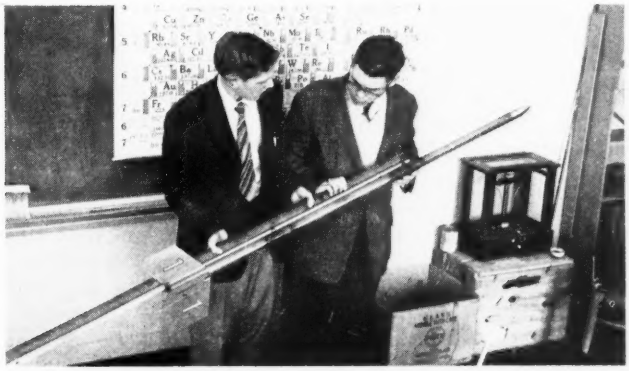
"I have, or I should say we, since I am working with two friends. . . have fired seven (7) home-made rockets and none have left the ground, so there must be something wrong with the pressure of the blast. How can we get the correct size of nozzle?

"Could you, if possible, send us the requirements for launching a rocket under the procedure of the law, since I know we are firing these missiles against the law?"

This letter, taken from the files of the AMERICAN ROCKET SOCIETY, is typical of the hundreds of similar letters recieved at ARS National Headquarters each year. It points up what everyone in the rocket or guided missile industry knows—that there are in this country today literally thousands of youngsters (and older men and women, as well) banded together in several hundred clubs, or in informal groups of two or three, to study, build and fire model rockets.

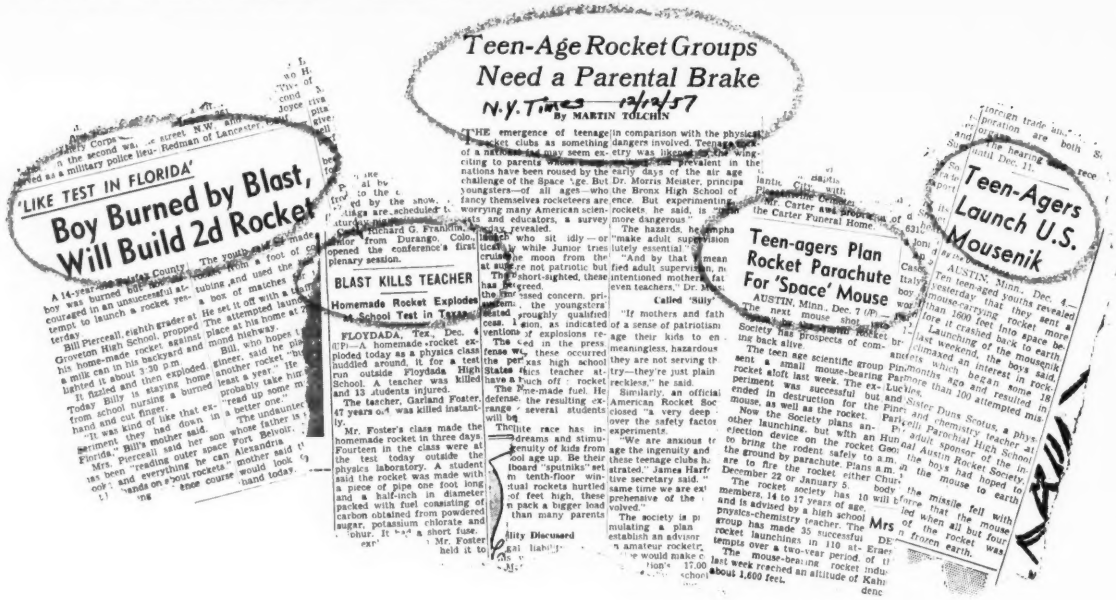
There can be little doubt at this point that rockets and space flight have captured the imagination of American youth. This interest is a healthy one, and bodes well for the future. However, it can be, and unfortunately has proved to be, a dangerous one as well. There is no need at this point to review the many newspaper and magazine articles of the past few months which have recited the numerous accidents which have taken place during unsupervised attempts by basement rocketeers to load or fire home-grown rockets.

However, such experiments have become a serious problem, and one that is worthy of a good deal of attention. It is in essence a dual problem, since proposed solutions should seek not only to prevent accidents in the course of amateur rocket experiments, but also to nurture the scientific curiosity which the rocket has aroused in the nation's youth.



Mike Kelly and Jim Davis, Washington, D. C., high school students (left), with rocket they built. Rocket blew up (right) in firing attempt supervised by Col. C. M. Parkin Jr. of ARS National Capital Section but no one was hurt as youngsters were 1000 yd away when it happened.

THESE HEADLINES TELL THE STORY . . .


'LIKE TEST IN FLORIDA'
Boy Burned by Blast, Will Build 2d Rocket
Teen-Age Rocket Groups Need a Parental Brake
N.Y. Times 12/2/57
By MARTIN TOLCHIN
BLAST KILLS TEACHER
Homemade Rocket Exploded
Teen-agers Plan Rocket Parachute For 'Space' Mouse
Teen-Agers Launch U.S. Mousenik

While ARS is not chartered to supervise or carry out rocket experiments, it can play an important role in this area, and the National Board has already taken action toward this end. The main element in the program now under consideration is a nation-wide chain of youth rocket groups, which would perform supervised experiments under conditions of maximum safety.

Registry of Amateur Rocket Clubs

Initially, an attempt would be made to set up a registry of youth rocket clubs and amateur rocket groups throughout the nation at ARS National Headquarters. Youngsters inquiring about their own rocket experiments would then be directed to an organized group in the area in which they are located.

As a further step in this direction, a rocket club handbook or guide is planned to assist youngsters or amateurs in forming such groups. The handbook would contain information on how to organize a club, how to develop a program, and how to go about getting government or industry help in setting up such a program. It could also contain a list of safety precautions to be observed in rocket experiments.

Also planned is a full-scale ARS youth rocket book, explaining what rockets are and how they work, outlining rocket experiments that can be performed, listing in great detail all the precautions that must be taken in performing such experiments, and, perhaps, containing suggestions for building a few safe and simple rockets.

Rocket clubs registered with ARS would submit full reports on their activities to the Society, and outstanding projects could be covered in the Society's publications.

Supervising this entire program would be an ARS Committee on Amateur Rocketry.

Many individual ARS members, sections and companies are already providing assistance to youth rocket clubs in their area of activity. Perhaps the most outstanding among such programs is one that has been carried out by the National Capital Section over the past two years.

Under the direction of Lt. Col. Charles M. Parkin Jr., Engineer Research and Development Laboratory, Fort Belvoir, Va., who heads the Section's Advisory Committee for Missile and Rocket Amateurs, the group has organized a full-scale program of assistance to youngsters and amateurs in the Washington, D. C., area who have expressed an interest in rocket experiments.

As Col. Parkin puts it, "We're reading about kids who have built rockets in their basements and tried to fire them from the nearest empty lot every day. There's no sense in trying to keep them from doing it, because they'll do it anyway, so why not help them do it safely?"

Toward this end, Col. Parkin has helped organize several youth rocket groups in Washington, has himself either supervised their experiments or arranged to have someone else with an intimate knowl-

edge of rocketry supervise such experiments, and has made arrangements to have model rockets built by such groups tested either at their own facilities or at government or company facilities in the area.

Only recently, the youngsters from one local rocket club who had built a model rocket went out to a government firing range to fire the rocket under Col. Parkin's supervision. The rocket blew up in the test, but since everyone was safely under cover 1000 yd away, no one was hurt.

Learned Their Lesson

"I'll guarantee that none of those kids will ever stay close to any kind of rocket when it's being fired in the future," the Colonel says. "They've learned their lesson. They know what can happen if something goes wrong. I've got a whole file full of letters from mothers expressing their appreciation of the work we've been doing with kids in this area.'"

At the National Board meeting in New York in December, Col. Parkin presented a plan calling for expansion of the National Capital Section's program into a nationwide ARS program. The plan was tentatively approved by the Board.

The program calls, first, for assignment of an officer to the Office of Director of Guided Missiles, Department of Defense, to work full-time on the project. As a start, efforts would be made, with the cooperation and assistance of local government, industry and private organizations, to expand youth rocket groups in the Washington area and form new clubs. Local high schools and science clubs would be canvassed and urged to foster interest in such activities. Later, a national program would be established, centering on ARS Sections throughout the country and again working through local high schools and science clubs.

The objectives of these clubs would be to stimulate the interest of youngsters in rockets, guided missiles and space flight, and to encourage them to enter scientific fields connected with research and development, engineering and production of rockets and guided missiles. These objectives would be accomplished through formal classes, supervised individual and group projects, static testing and live firings of model rockets, (CONTINUED ON PAGE 70)

TOMORROW'S ROCKETEERS: Top to bottom, Jimmy Blackmon and the 6-ft rocket he built in his basement; James W. Samuel and the display on micrometeorites he prepared for the Lehigh Valley Science Fair in Allentown, Pa.; Ted Panayatoff and his rocket propulsion exhibit, displayed at the Mobile, Ala., Regional Science Fair; and a design for a liquid rocket prepared by William P. Love for the Florida State Science Fair at Gainesville.

The notorious unreliability of complex equipment

The long-neglected reliability problem grows more important as missiles become more complex . . . Here, an expert examines the problem and suggests some ways and means of keeping missile reliability at specified levels

By Robert Lusser

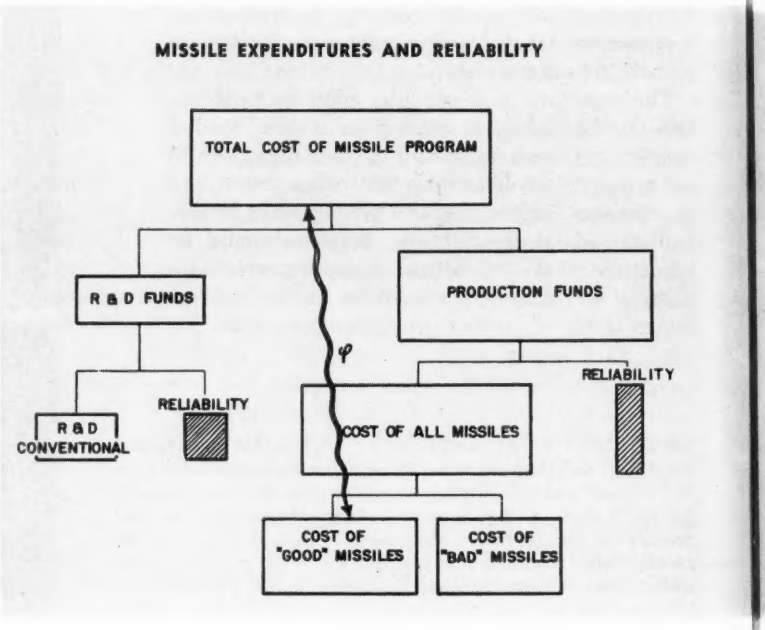
REDSTONE ARSENAL, HUNTSVILLE, ALA.

Robert Lusser, now Reliability Coordinator at Redstone Arsenal, is one of the country's top experts in the field of missile reliability. In 1948, he came to this country from Germany to accept a position at the Naval Air Missile Test Center, Point Mugu, Calif., where he specialized in the problem of missile reliability and wrote several reports now considered classics in this field. He has been at Redstone Arsenal since 1953. Prior to coming to this country, he was head of the Preliminary Design Dept. of Messerschmidt Aircraft Co., director of aircraft development at Heinkel Aircraft Co. and, as director of the Fieseler Aircraft Co., was in charge of the development of the V-1 flying bomb.

A DECADE AGO, reliability was not considered a serious problem. Products had to be of good quality or the producer would lose prestige and customers. However, "good quality" was a nebulous term then, and still is. For example, a component reliable enough for a simple walkie-talkie is still considered reliable enough for employment in very complex equipment such as a guided missile, which is, of course, a gruesome mistake.

In the field of piloted aircraft, the problem of reliability has always been taken seriously because human lives are at stake. As a result, it was excellently solved through careful design of vital structures.

With the advent of guided missiles, however, reliability became a major problem. Initially, missiles were thought of as being particularly reliable because pilot error was eliminated. Yet missiles



refused to become as reliable as specified or hoped for. All too often, something went wrong. We began to worry and to think.

Nobody was really alarmed, though. It was widely believed that missiles were essentially made of the same stuff as piloted aircraft, and the argument was often heard: "We have reliable airplanes. Why shouldn't we be able to make our missiles reliable? It just takes time."

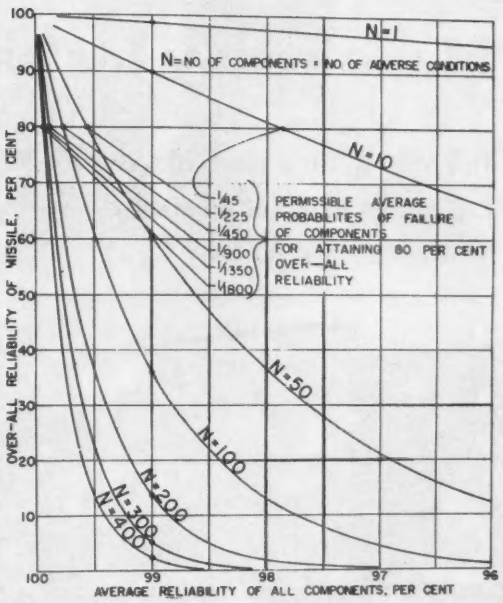
This optimism is not justified, however. It is based on the erroneous assumption that the over-all reliability of a complex assembly somehow equals the average of the reliability of its components. Actually, the over-all reliability equals the product of the reliability of the components, as indicated by the so-called reliability formula: $P_{\text{over-all}} = P_1 \times P_2 \times P_3 \ldots P_n$ whereby P_1, P_2, P_3 . . . are the reliabilities of the n components of an assembly.

It is of prime importance to understand the meaning of this formula. It teaches that each component decreases the over-all reliability by its own reliability factor. If an assembly consists of only a few components, the over-all reliability might be quite acceptable. But if it consists of a great many—possibly thousands—of components, the over-all reliability may turn out to be awfully low.

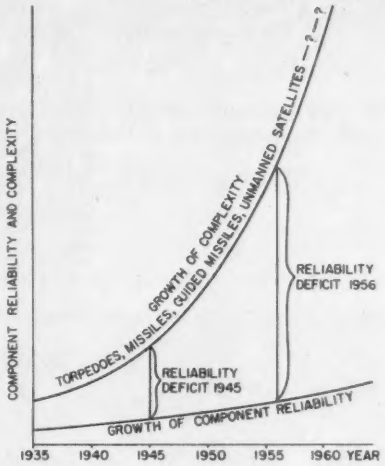
The crucial relationship between the over-all reliability and the reliability of the components is shown in the graph at the top of this page.

This diagram indicates that a simple missile consisting of 100 components, each having 99 per cent reliability, will have a reliability of only 36.5 per cent. Approximately two (CONTINUED ON PAGE 74)

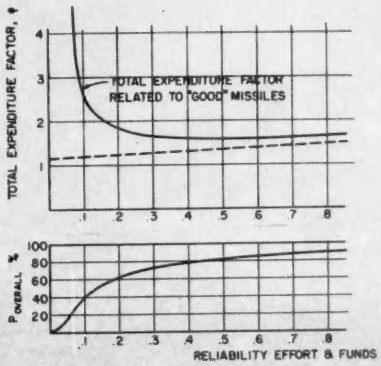
OVER-ALL RELIABILITY AS A FUNCTION OF COMPLEXITY AND COMPONENT RELIABILITY



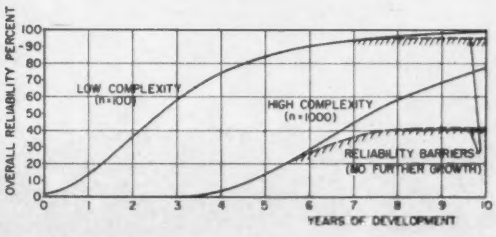
THE RISING RELIABILITY DEFICIT



RELIABILITY AND EXPENDITURES AS A FUNCTION OF RELIABILITY FUNDS



GROWTH OF RELIABILITY AND THE RELIABILITY BARRIER



Make-ready for satellite launching

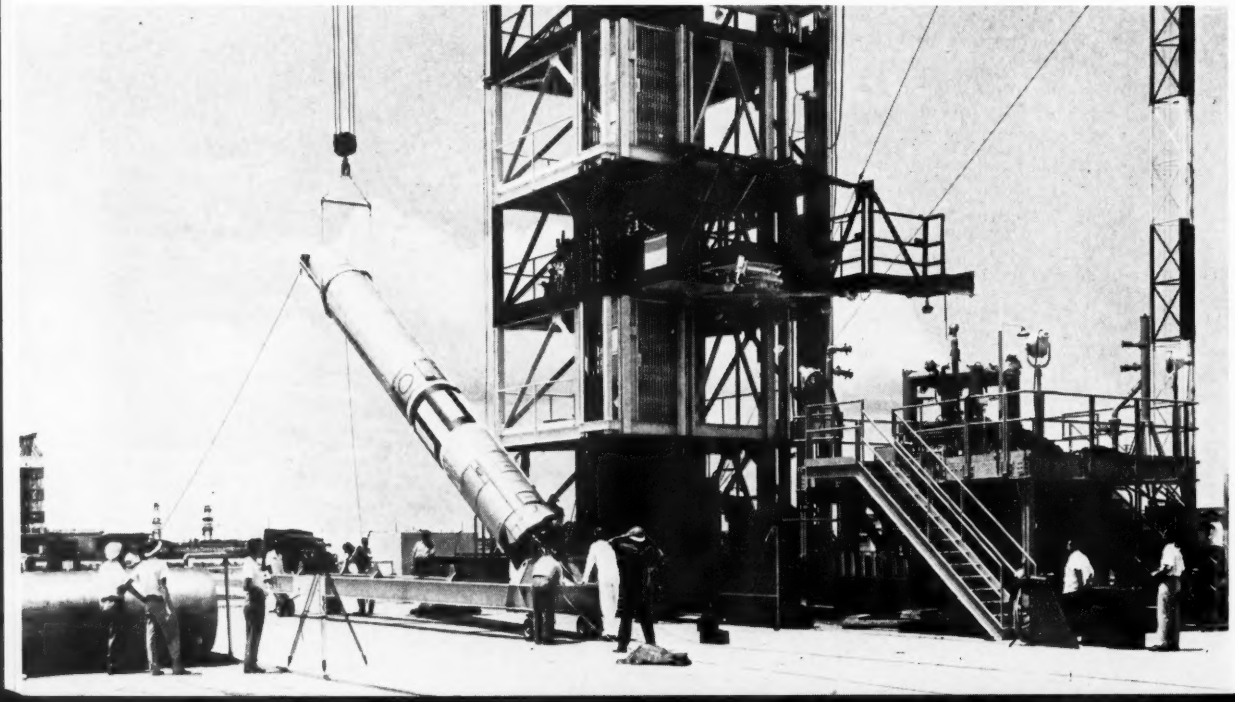
This step-by-step story of Vanguard TV-3 from the time it arrived in Cape Canaveral until the moment it was fired suggests the magnitude of the job

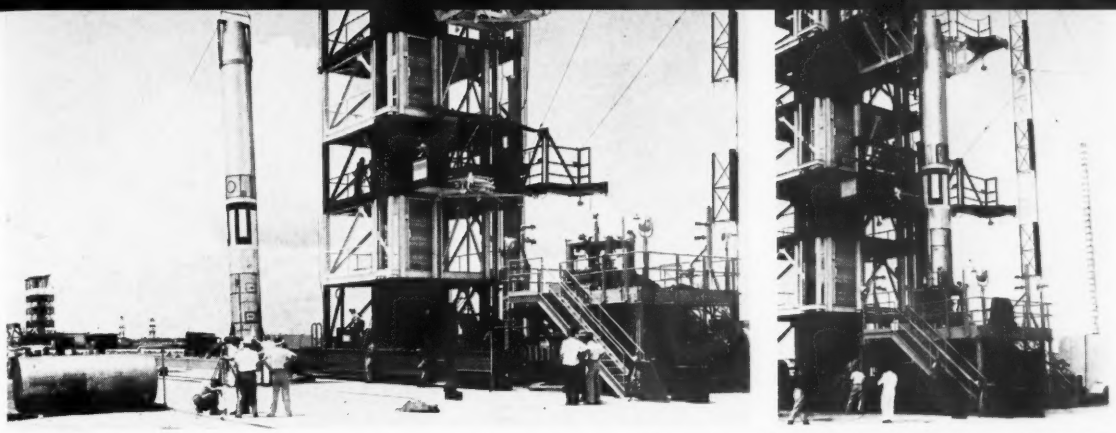
DOLLY OUT: Aboard special dolly, first stage of TV-3 is carefully maneuvered out of the hanger.

THERE'S a lot more to launching a large rocket vehicle like the Vanguard satellite carrier, or an IRBM or ICBM, than the dramatic countdown, tense holds and final, climactic contact of the firing switch. From the moment the vehicle rolls off the trucks that bring it to Cape Canaveral to the time it climbs skyward on a tongue of flame, many assorted activities and much concentrated effort go into getting it off the ground.

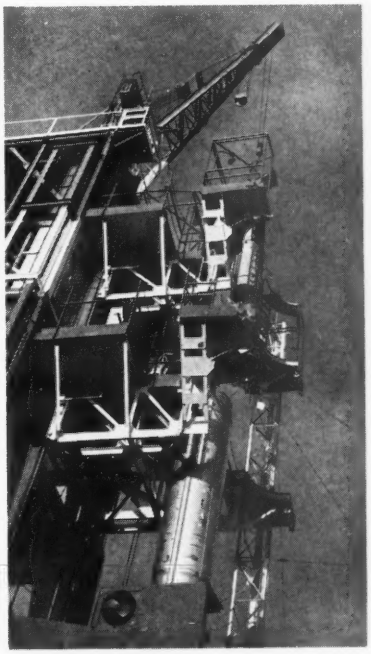
In the case of a multistage vehicle like the Vanguard launcher, putting together the vehicle is in itself a highly complex and precise engineering job. TV-3, the ill-fated Vanguard test vehicle which blew up only a few seconds after take-off, is shown here from the time of its dismembered arrival at the Canaveral launching pad, through assembly, erection and fueling, to the moment of firing, when men, machine and Mother Nature merge into one final effort before fate takes over.

GENTLY DOES IT: Vehicle is lifted off dolly while technicians hold guy lines.

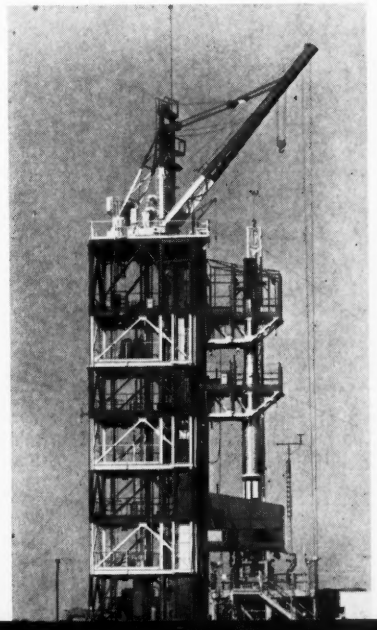


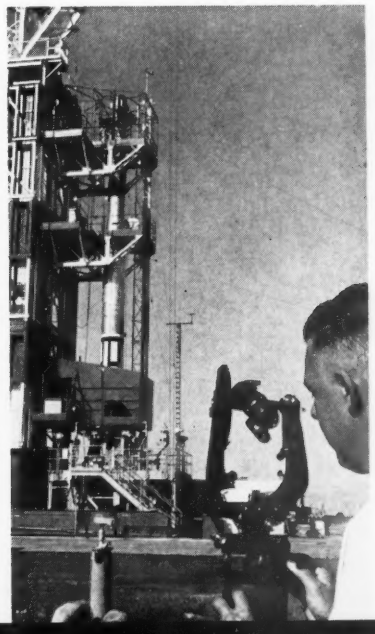


FIRST STAGE is raised upright, lifted clear of dolly and set atop launch stand, where harness and guy lines are removed.



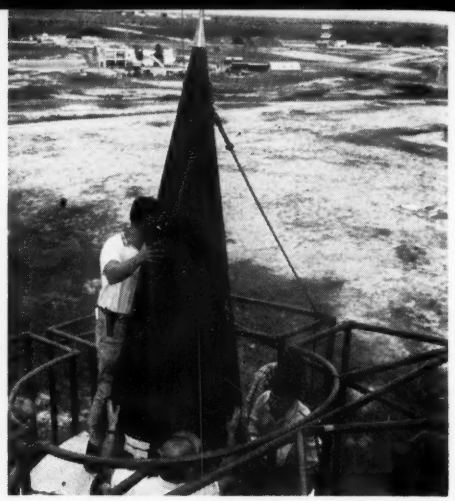
DOLLY IN: Gantry crane hoists second stage off dolly and into position above first stage.



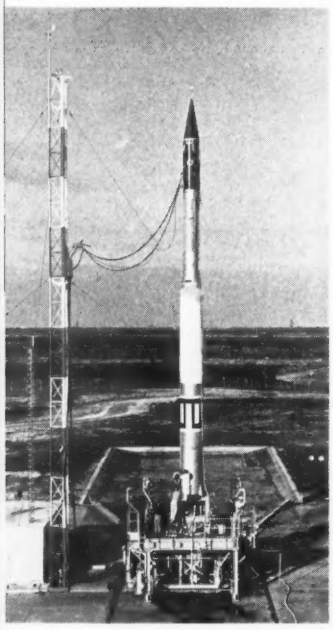


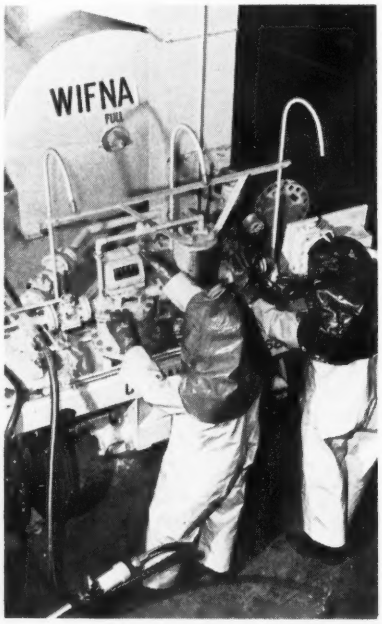
IN POSITION: Lowered into position atop first stage, second stage sheds its tackle. Technician (right) moves in to check alignment.

PAYLOAD: Technicians attach 6.4-in. baby satellite to third-stage rocket, inside second-stage nose.

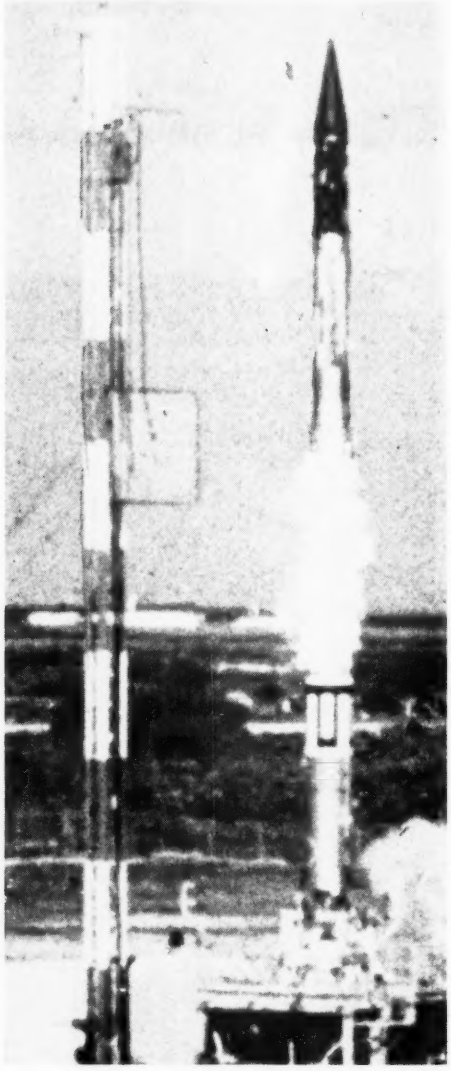


NOSE CONE, for streamlining and protection, finishes off the 72-ft vehicle.





ON ITS OWN: Gantry is removed after fuel and electrical lines are connected. At right, technicians prepare for second-stage fueling.



TAKE-OFF: Climax to a lot of hard work, this is the moment man lets go and fate takes over. In this case, fate was unkind.

INSIDE BLOCKHOUSE, Vanguard crew checks instrument consoles in preparation for upcoming firing.

Radiological hot cell

New facility at ARDC's Wright Air Development Center permits study of Air Force materials for use in missiles and aircraft in a radiation environment and of radiation-catalyzed chemical reactions

THE EFFECTS of gamma rays on Air Force materials are studied in a new laboratory facility at the Air Research and Development Command's Wright Air Development Center, near Dayton, Ohio.

The "radiological hot cell," completed in January, 1957, uses 23,000 curies of cobalt-60 to irradiate specimens in air. Previous methods required placing materials samples in watertight capsules. These were then lowered into a deep water-filled well which housed the radiation source.

The cell is used by the Materials Physics Branch of WADC's Materials Laboratory to study the behavior of AF materials for use in missiles and aircraft in a radiation environment. The source is also used to study radiation-catalyzed chemical reactions which can not be studied through conventional chemical techniques.

Built at Cost of $142,000

Built at a cost of $142,000, the cell consists of two rooms, each 7 ft long, $7^1/_2$ ft wide and 12 ft high. A 3-ft thick dividing partition between the rooms may be rolled into the chamber's back wall to provide one large chamber, 7 by 18 ft in size, making it one of the largest radiological hot cells in the U. S.

There are two storage facilities for radioactive materials. Cobalt-60 sources and other high-intensity items are stored in a water-filled well, 17 ft deep, with a stainless steel shell. Isotopes used in radiochemistry are stored in 12 horizontal tubes in a chamber wall. Each tube handles 10 curies.

The chamber's size enables WADC scientists to expose large quantities of materials to radioactivity. The facility also allows work on equipment which has become radioactive through exposure to activating radiation.

Effects of radiation on equipment and materials—especially organics like rubber, plastics and lubricants—are a continuing study. Improvement of materials through radiation, as was accomplished in 1954 at WADC in the vulcanization of rubber by gamma radiation, is also under study.

Walls Were Made 3 ft Thick

The original design for the chamber called for concrete walls 1 ft thick. As finally constructed, the walls were made 3 ft thick to accommodate the present source. Steel forms filled with 36 in. of packed magnetite ore form the fourth wall, containing the access doors. All inside surfaces of the chamber are steel.

One access door fits into the front wall of each room. An observation window in each door is constructed of two panels of special glass filled with 36 in. of zinc bromide solution to protect observers.

Two mechanical hands—called master-slave manipulators—extend inside each room through the access doors. The operator stands outside the chamber and uses the hands to perform experiments inside the chamber.

Utilities—water, gas, air and electric power—were installed in the chamber, along with a carbon dioxide fire-extinguisher system.

Detailed design and all construction work on the hot cell was carried out by R. V. Harty Co., Inc., Detroit, Mich.

Soviet satellite instrumentation

Comparison of Russian and U. S. techniques reveals different approaches to the problem of measuring solar X-ray and ultraviolet radiation

By Herbert Friedman

U. S. NAVAL RESEARCH LABORATORY, WASHINGTON, D. C.

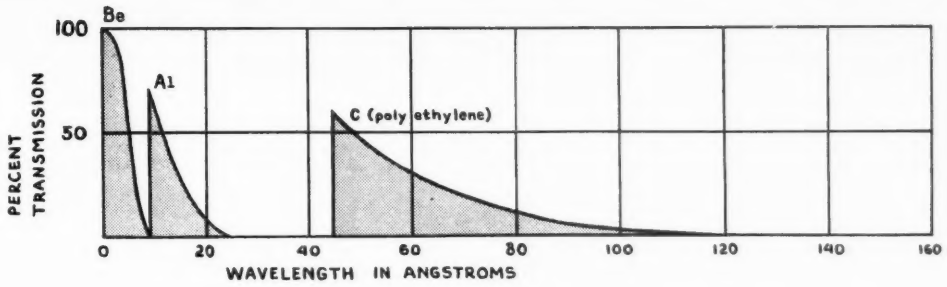
AT THE CSAGI-sponsored Rocket and Satellite Conference held at the National Academy of Sciences in Washington the week that Sputnik I was launched, S. M. Poloskov of the U.S.S.R. presented a paper on Soviet plans for satellite experiments. Russian newspaper photographs of instruments flown in Sputnik II fit Dr. Poloskov's exposition of their radiation experiments and a more detailed description by S. L. Mandel'shtam and A. I. Yefremov which the Russian delegation left with the U. S. National Committee for the I.G.Y. The Soviet scientists' approach to the problem of measuring solar X-rays and ultraviolet in satellites involves instrumentation techniques somewhat different from those used in American rocket experiments and planned for U. S. satellites.

Herbert Friedman has since 1942 been head of the Naval Research Laboratory's Electron Optics Branch. Since 1949, he has been actively engaged in upper atmosphere rocket research, particularly in the field of solar-terrestrial relationships, and in this capacity was in charge of NRL's solar flare rocket experiments at San Nicolas Island, described on page 44. A member of the Working Group on Internal Instrumentation of the IGY Technical Panel on Earth Satellites, Dr. Friedman has played an active role in instrumentation of Vanguard.

Employ Secondary Emission Multiplier Tubes

The Russian measurements are based on the use of secondary emission multiplier tubes as the detectors for both X-rays and ultraviolet light. Since the satellite travels in a comparatively high vacuum, the cathode and dynode elements of the multiplier need not be housed in a vacuum tight envelope. Beryllium-copper dynodes and cathode are used in an open structure in the manner described in this country in 1939 by J. S. Allen. Although this material has a secondary emission ratio of only two, as compared to four for alkali-metal oxide surfaces, it has the advantage of a short wave length threshold (2300–2500 Å according to Mandel'shtam and Yefremov) and low thermionic noise. The photosensitivity rises at first to a maximum yield of about 10^{-4} electrons per quantum as the wave length decreases below 2300 Å and then reaches a minimum at about 1700 Å. At shorter wave lengths, the internal photoeffect begins and the efficiency may rise abruptly to a yield of the order of a few per cent.

Since the S.E.M. tube is a broad band detector, information about narrow bands of the solar spectrum is obtained by the use of differential filters. For the X-ray range, filters of beryllium, aluminum and polyethylene are chosen in such thicknesses that they transmit the spectral ranges shown in the graph on page 33. Because the polyethylene is transparent to wave lengths in the near ultraviolet, which would produce signals in the S.E.M. tube, it is backed with a thin opaquing foil of beryllium. The filters are placed over the holes in an aperture disk which rotates before the cathode of the



Spectral ranges transmitted by filters used in Soviet solar radiation instrumentation.

S.E.M. tube. The entire unit is housed in such a way that solar radiation reaches the multiplier only by passing through the filter that happens to be aligned with the photo-cathode at any given time.

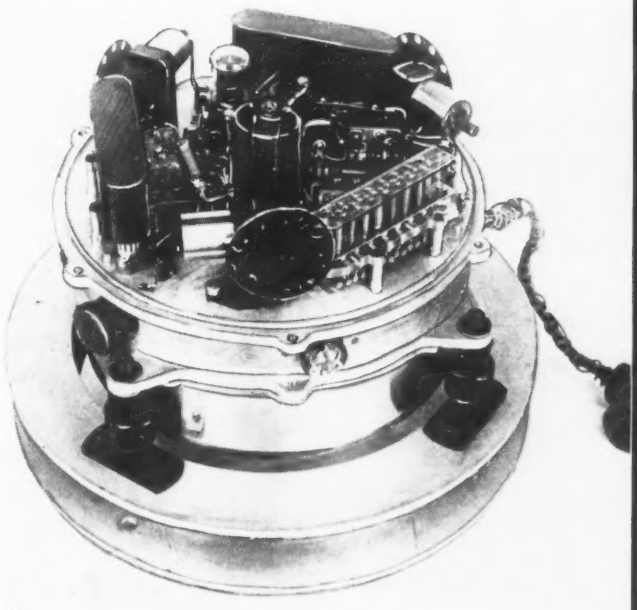
In the photo at right, three filter disks are seen spaced at 120 deg intervals about the spin axis of the satellite. The apertures show clearly in the two units in the background. It is difficult to make out any detail in the disk in the foreground. Behind and to the right of this disk is a device that appears to be a linear electron multiplier structure of perhaps 16 dynodes. The use of three units is apparently intended to provide at least one unit capable of seeing the sun at any given time for any orientation about the spin axis.

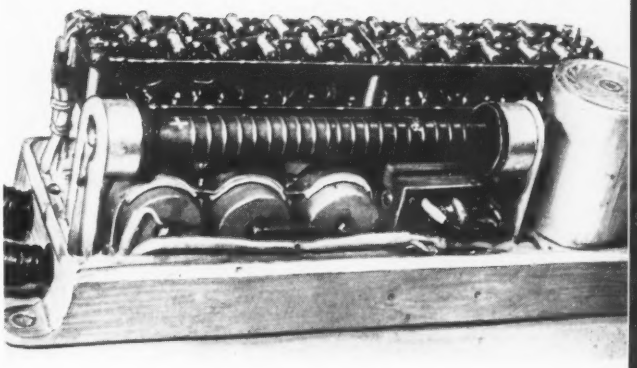
Lithium Fluoride Filter Disks Used

To measure the intensity of the ultraviolet Lyman Alpha line of hydrogen, filter disks of lithium fluoride are used. It is implied that lithium fluoride can be treated in such a way as to reduce its short wavelength transmission to the point where it will not pass Lyman Alpha (1216A). Such a doped lithium fluoride is alternated with a clear crystal to bracket the Lyman Alpha line between the two transmission limits.

It is possible that the filter wheels shown in the photo include both X-ray and Lyman Alpha filters, thereby performing all the spectrum measurements with the same detectors. It is also mentioned that blank positions are left in the aperture wheels to provide signals for calibration checks and aspect indication. Since the broad integrated range of the solar spectrum to which the S.E.M. tube responds is not expected to vary appreciably, the direct measurement without filtration gives standardization of the instrumentation.

The electronics portion of the experiment consists of power supply, (CONTINUED ON PAGE 82)





Solar radiation (above) and cosmic ray (below) instrumentation carried in second Soviet satellite.

A tactical Pc control system

Designed for field use, this unusual system stresses interchangeable components and ease of maintenance while meeting rigid specifications

By Louis de Bottari

SERVOMECHANISMS, INC., HAWTHORNE, CALIF.

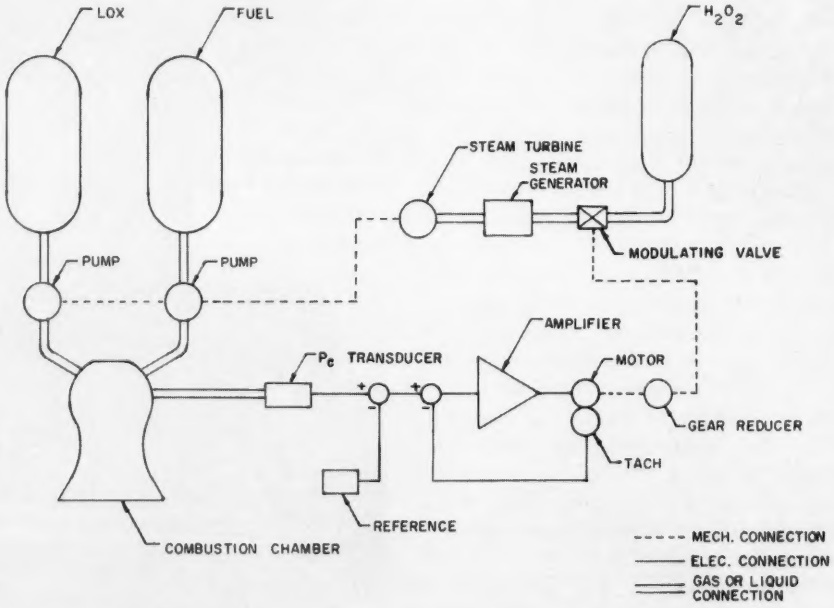
MUCH attention has been given in the past to the theory of chamber pressure control systems for liquid rocket engines. Rather than go into the question of whether an engine can be controlled, let's assume here that an engine is stable and can be kept to a certain thrust tolerance in flight, and examine the development of a system now being used to maintain thrust level of an engine at a specified magnitude.

The control system described here, designed for tactical use on weapon systems by troops in the field, was developed in conjunction with the Army Ballistic Missile Agency at Huntsville, Ala., with the cooperation of the Rocketdyne Div. of North American Aviation.

The system was developed with certain design criteria in mind. By careful design, the system can be modified to include other types of controls, thus providing growth potential and at the same time increasing reliability by using some components of the system over and over again. In addition, certain problems were avoided by designing some details into the system at the very beginning. The system described here was designed for utilization with a guidance system to simplify the guidance computer.

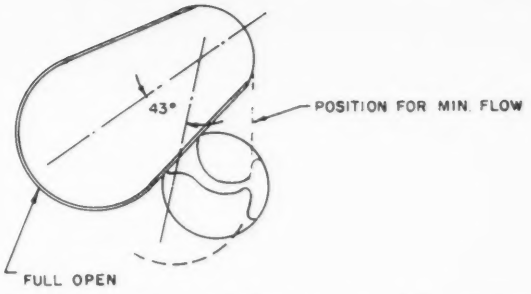
Based on a paper presented at the ARS Annual Meeting in New York Dec. 2-6, 1957.

CHAMBER PRESSURE CONTROL SYSTEM



A diagram of the system on the facing page illustrates as may be seen, the sensing point is chamber pressure. The transducer converts this pressure into electrical voltage which is compared with a reference, and the error is then amplified to a level sufficient to actuate a two-phase servo motor. The motor rotates a modulating valve in the hydrogen peroxide line.

This valve in turns varies the hydrogen peroxide flow rate to a steam generator and changes the rpm of the fuel and lox main pumps. Stops are incorporated within the valve so as to reduce the possibility of failure of the entire vehicle if the control system should fail for some reason. These stops are adjusted for the minimum flow required to maintain the engine at a satisfactory thrust level. Shaping of the orifice in the valve, shown in the drawing at top of this page, maintains a pressure drop linear with angular travel to keep the gain of the system constant. Range of control on this system is $\pm 7^1/_2$ per cent from nominal chamber pressure.

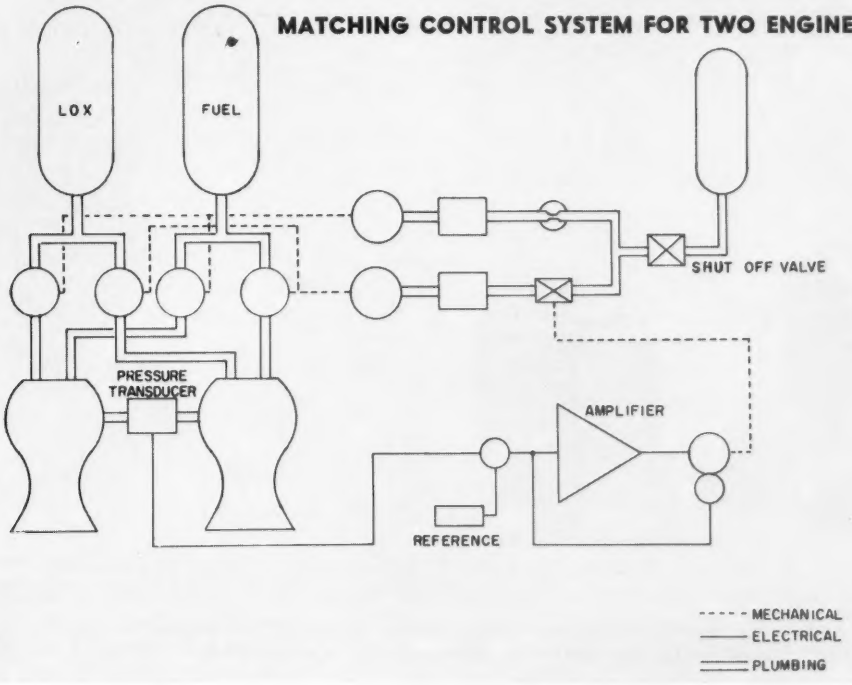


Specially shaped valve orifice, showing relative position of valve and orifice.

Good Sensing Element Developed

At the start of the development program, it was felt that the system would be only as good as the sensing element used. Consequently, a good deal of time and effort was spent in developing a pressure transducer with excellent zero-stability characteristics. Zero stability was maintained within 0.3 per cent of full scale when the transducer was exposed to all the environmental conditions that would be encountered by the system. In addition, interchangeability was required. This was achieved to the point where all the transducers in the system can be interchanged without making any adjustments and without affecting total system accuracy.

Shelf-life zero stability has been plotted for a period of one year and has been found to be within 0.1 per cent of full scale pressure. This was an important factor because the system was to be fired by troops, and it was mandatory to reduce adjustments to a minimum to make the system as reliable as possible.



If troops were required to set a reference pressure before each firing, the usefulness of the system would be diminished because its accuracy would then depend on how accurately the correct pneumatic pressure could be obtained and how accurately the reference potentiometer could be adjusted. By maintaining close tolerances in the pressure transducer, it is possible to change the transducers without readjusting the entire control system in the field. This is a big point, not in the R&D phase, but during the tactical phase, when troops are required to maintain the system.

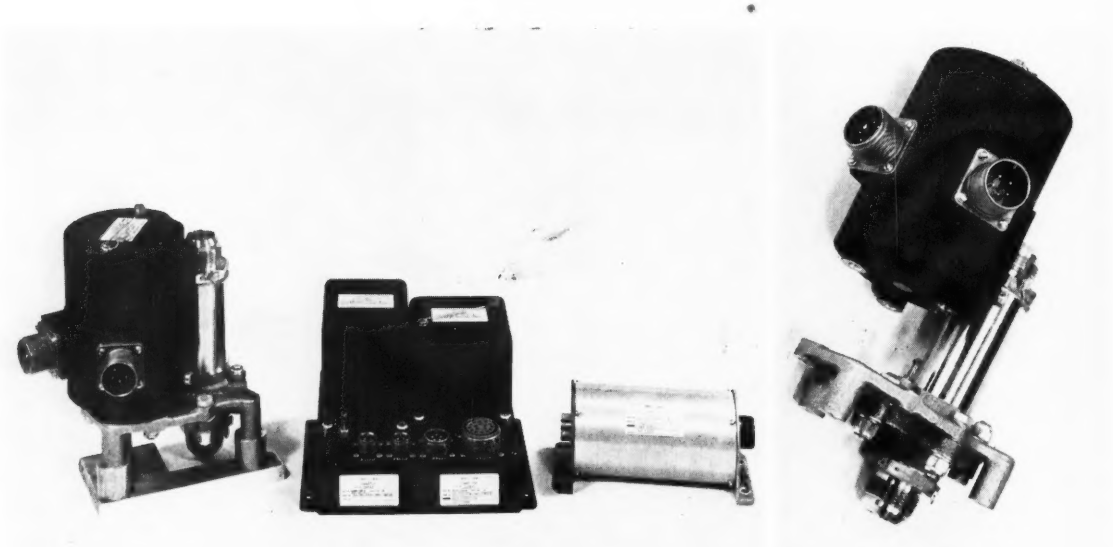
Few Adjustments Necessary

The fewer adjustments required in a control system, the more reliable it becomes, because the human element does not enter the picture. This philosophy was carried over into both the valve and the amplifier assembly. One example is the ease with which "O" rings can be removed from the valve. This is important if a vehicle is put in storage for a few years and the "O" rings must then be changed. As can be seen in the photo on this page, the actuation portion of the valve can be completely disconnected from the valve itself, thereby facilitating "O" ring changes. The complete gear train mechanism, also shown in the photo, can be installed on any other valve without special jigs or tools.

The amplifier and reference signal generator are constructed as plug-in packages that can be removed and replaced by removing only four fasteners. No adjustment is required in replacing an amplifier. Reference signal generator adjustment consists of adjusting a dial to the same setting as the one replaced.

To facilitate ease of maintenance, as well as ease in learning how the system operates, all components associated with each major function are in separate boxes, as shown in the photo on this page. The importance of interchangeability is exemplified by a weapon system. It is a lot simpler to change a pressure transducer, let's say, than it is to change the entire system. If interchangeability is not built into the system at the start, a number of problems would exist if a defective transducer were detected before a firing. It would mean removal of the entire system, which means removing the valve and all the plumbing associated with the valve, as well as removing the amplifier assembly and also the transducer. Even though the amplifier assembly and the valve might be perfectly all right, the entire system would have to be removed because of the defective transducer. This would involve many hours of work just because the interchangeability feature was not designed into the system at the start of the program.

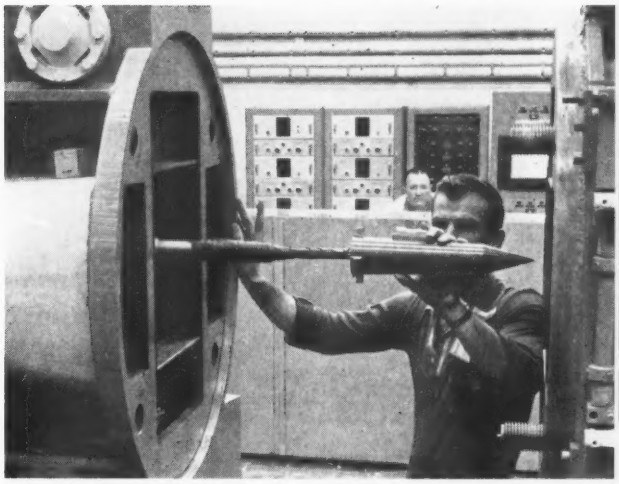
It should be kept in mind that addition of a control system should not be a green light to widen tolerances on other components, with the idea that the control system will correct for them. This only makes the control system more of a series circuit, thereby decreasing the (CONTINUED ON PAGE 62)



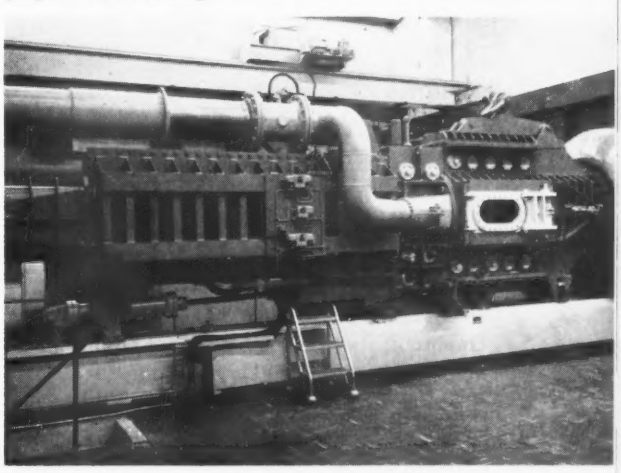
Separation of components associated with each major function into individual boxes (left) facilitates maintenance. "O" rings can be changed easily, since actuation portion of valve can be disconnected from valve itself, as shown at right.

New wind tunnel for ABMA

(*U. S. Army Photos*)



Technician positions missile model in wind tunnel preparatory to testing.



Side view of the new ABMA 14 by 14 in. trisonic wind tunnel.

HUNTSVILLE, ALA.—A new 14 by 14 inch trisonic wind tunnel is now in use at the Army Ballistic Missile Agency here.

The tunnel, designed by ABMA engineers, and built by Watertown Arsenal in Watertown, Mass. is capable of providing Mach numbers in the subsonic, transonic and supersonic ranges from Mach 0.4 to 6.0.

Completely automatic in operation, the tunnel investigates a model ballistic missile on one Mach number in 40 sec. It is employed to measure aerodynamic characteristics, heat transfer and missile attitude control. Several engineers can watch a test at the same time by means of closed circuit television.

Quick Interchange of Sections

Unique design permits quick interchange of two test sections. The tunnel operates on the blowdown principle, exhausting either to the atmosphere or to vacuum with stagnation pressures ranging up to 7 atmospheres.

High pressure air is supplied from a 3500 cu ft storage battery at pressures up to 3500 psi. Stagnation pressure is automatically controlled by an electronic controller actuating a hydraulic operated control valve.

Heat can be added with a capacity type heater utilizing hot water at 200 F delivered continuously at a rate of 1500 gal per min.

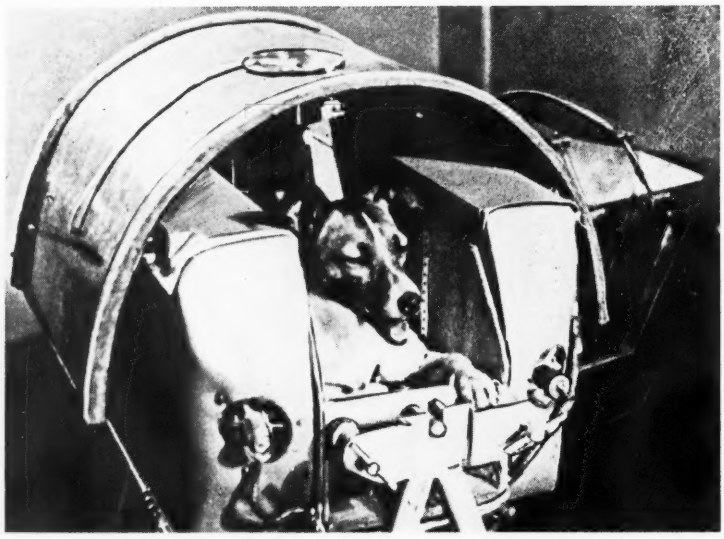
Data are automatically read out on IBM cards and later tabulated from the cards.

A transonic test section employs perforated walls with four sides. From subsonic to Mach 1.5, a conventional sonic nozzle is used, and from Mach 1.5 to 2.5, exchangeable fixed contour nozzles will be used. By removing the test section and lowering it into a pit, nozzles can be removed and exchanged with an overhead crane in about 20 min.

The supersonic test section utilizes a symmetrical fixed contour, variable Mach number nozzle to obtain numbers from Mach 3 to 6. After flow calibrations have been completed, Mach numbers can be remotely selected and changed very quickly.

The unique feature of retracting the diffuser and model housing 30 in. downstream from the end of the test section allows complete freedom of access to the model and affords a test section design with windows but no door joints.

The tunnel is a facility of the Aeroballistics Laboratory, which conducts investigations pertaining to design, development and test of controlled ballistic missiles.



SPACE DOG: Where man cannot go, the dog must precede and serve him.

Life in Sputnik

A Russian biologist examines problems involved in keeping a living organism alive in space and reveals Soviet approaches

By P. Isakov, M.Sc. (Biology)

AN EXTREMELY difficult and exceptionally important stage in the mastery of cosmic space has been attained. For the first time in history, man-made devices have penetrated interplanetary space and are revolving around the earth.

Following the first artificial satellite, which proved the possibility of systematic radio communication with cosmic space, another Sputnik is circling the globe. It is much larger in size, equipped with instruments for research and even carried a passenger, the dog Laika. This experiment was carried out to verify a number of theories concerning the effects of cosmic space on living beings, and to test protective devices necessary to prevent harm or even death to living beings carried in a space vehicle. The data deriving from this experiment are necessary for organizing future flights of manned vehicles to the moon, Mars and Venus.

Flight of both animals and man in space is possible only in hermetically-sealed chambers in which the air, both in composition and pressure, is similar to that on earth.

All liquids in an organism, particularly blood, contain dissolved gases—oxygen, nitrogen, carbon dioxide, etc. If the barometric pressure of the air drops, the dissolved gases leave the blood. In case of a sharp drop in barometric pressure, such a quantity of gases may escape from the liquids in the organism as will involve grave consequences, and at times even full derangement of the organism's physiological functions.

Such derangement can occur if the chamber is suddenly no longer airtight. Naturally, it is necessary to take precautionary measures to prevent such accidents.

Two Methods are Combined

How can this be done? First, by maintaining necessary barometric pressure in the chamber. But such a method is not very reliable, since any breach in the wall, anything making it less than airtight, would have grave and often irreparable consequences. The second method is to use specially-designed clothing or space suits.

In practice the two methods are combined. Baro-

metric pressure is maintained in the chamber and special space clothing is used. The suit is brought into action when the chamber is no longer airtight.

The flight of animals in a satellite makes it possible to ascertain how reliable the airtight chambers are, to determine whether space suits are adequate, to work out a method of feeding and supplying water to organisms under these conditions, and to answer a number of other questions.

A suitable environmental temperature is an important condition for the normal existence of human beings. On earth, organisms are subjected to a fluctuation of the temperature of the environment in a relatively small-range—approximately from +70 to —70 C. However, this does not mean all animals are adapted to such fluctuations in temperature. Many can withstand only a considerably smaller temperature fluctuation. That is why thorough investigations have to be made of interplanetary space where temperature fluctuations can be immeasurably greater than this.

Solar and Cosmic Radiation Studied

Sputnik II, with a dog in it, has already shown that Soviet scientists have gone a long way toward solving the problem of creating the necessary temperature regime within the satellite. During the first hours of flight, the dog behaved calmly and its general state was satisfactory.

With the help of sputniks, the influence of various forms of solar and cosmic radiation on living organisms can also be studied.

There are no grounds for fearing ultraviolet or X-rays excessively. People on earth have long had to deal with such radiation, and protective measures have been worked out. There is no reason to assume that these problems will baffle designers of manned space craft.

Cosmic rays, or cosmic particles, as they are more properly called, can be much more dangerous. They consist of nuclei of different chemical elements. Cosmic rays contain hydrogen nuclei to a great extent (about 80 per cent), along with some heavier nuclei, such as iron.

The velocity of cosmic ray particles is exceedingly great, approaching the speed of light. Possessing tremendous kinetic energy, such particles, clashing with molecules of other substances, cause their dissociation and disintegration into ions. Ionization of molecules also takes place when cosmic particles penetrate the tissues of an organism, leading to the destruction of cells and to morbid phenomena similar to those caused by gamma-radiation arising from nuclear reactions.

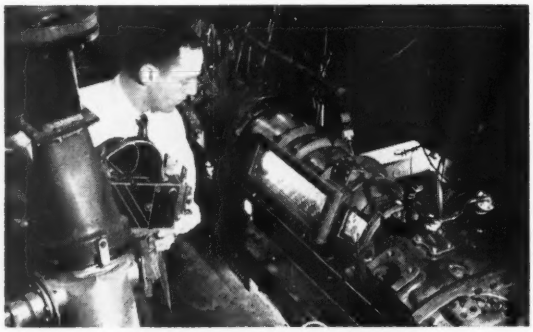
The penetration of one particle into the tissue of an organism is still not dangerous. Even particles of such heavy elements as zinc and iron cause damage only to about 15,000 cells. Compared with the total number of cells in an organism (about 10^{12}), this, of course, is infinitesimally small. However, *where* a particle strikes is important. It is one thing if a particle causes the destruction of fat cells in the subcutaneous layer, and an entirely different matter in the case of the nerves of the cardiac muscle or vitally important centers of the cerebrum.

The question naturally arises: How is the organism to be protected from (CONTINUED ON PAGE 49)

Schematic drawing from *Izvestia* shows Sputnik II biological experiments. Top to bottom: Factors acting on the animal's organism are cosmic rays, solar radiation and weightlessness. Controlled functions of the organism are breathing, heart action and blood pressure. Information goes to radio transmitter which sends signals to receivers on the ground, where they are converted into measurements.

NACA Lewis Flight Propulsion Laboratory

Research center for tomorrow



Research to find new fuels with a high energy content has been a major Lewis effort for years. Here, an engineer operates combustion test apparatus in high energy chemical fuel study.

Ion propulsion model, operating at near vacuum conditions, produces thrust, detected by small wheel at right of jet. Test is part of study of advanced propulsion systems.

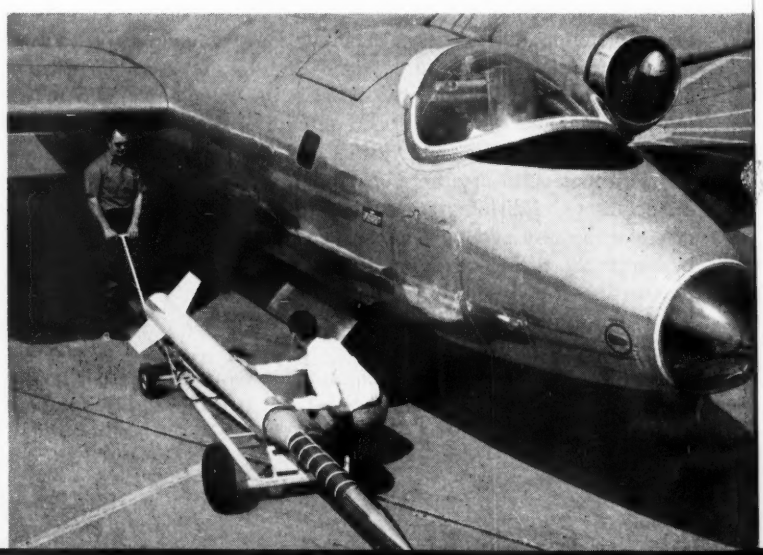
EARLY in October, the National Advisory Committee for Aeronautics opened the doors of its Lewis Flight Propulsion Laboratory in Cleveland, Ohio, for what has become an outstanding annual event—the inspection of one of the three major NACA facilities.

In these laboratories—the other two are Ames Aeronautical Laboratory at Moffett Field, Calif. and Langley Aeronautical Laboratory at Langley Field, Va.—scientists and engineers are seeking the answers to a formidable list of questions about the aircraft, rockets and guided missiles of the future.

Seek Answers To Many Questions

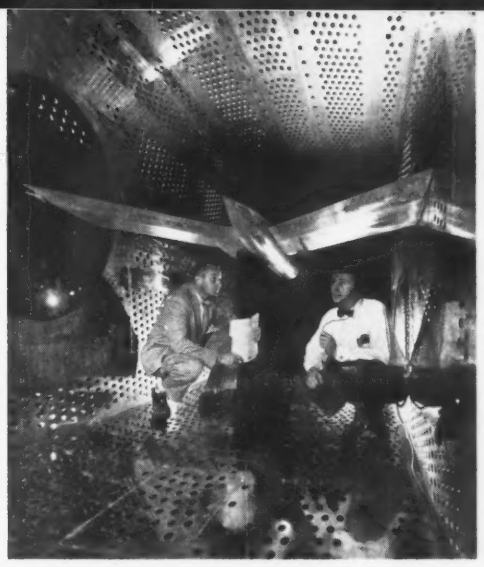
These questions are many and varied. What kinds of fuels will power tomorrow's rockets and missiles? What role will air-breathing engines play in propelling advanced vehicles? How will nuclear power be applied in flight? What other types of advanced propulsion systems are feasible? What kind of materials will be needed? How should these vehicles be designed?

The laboratories, wind tunnels and other test facilities at Lewis shown on these pages and viewed by visitors during the inspection tour will furnish the answers to some, if not all, of these questions. In so doing, they will help not only in conquest of the air, but of space itself.



Two-stage hypersonic rocket is prepared for in-flight launching from B-57A bomber. The 15 ft, 440 lb rocket, launched at altitudes above 45,000 ft, reaches Mach 10.5 at end of second-stage burnout.

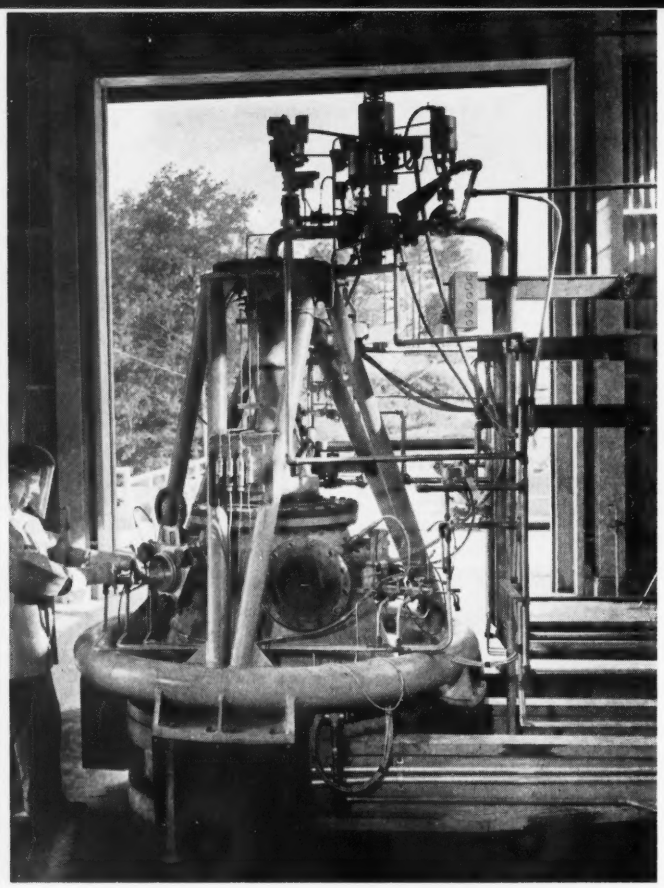
Model of theoretical Mach 4 turbojet engine. Compressor-turbine section is dwarfed by large air inlet and expanded exhaust nozzle. Short length comes from use of three, rather than 12 to 15, compressor blade rows.

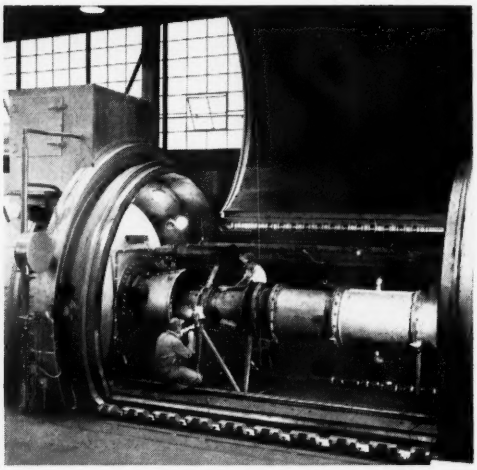


Engineers check model installed in test section of Lewis 8 by 6 ft wind tunnel, recently modernized at cost of $2 million. Tunnel now produces transonic, as well as supersonic, air flows.

$2.5 million rocket engine research facility, completed last August, is latest addition to Lewis Laboratory. Major research here centers on testing of moderate size rocket engines utilizing new high energy fuels.

Lewis 10 by 10 ft supersonic wind tunnel. Steel air duct at right leads to test section, housed in long, narrow structure in center. Building at left and at other end of steel duct house compressors which supply air flow.

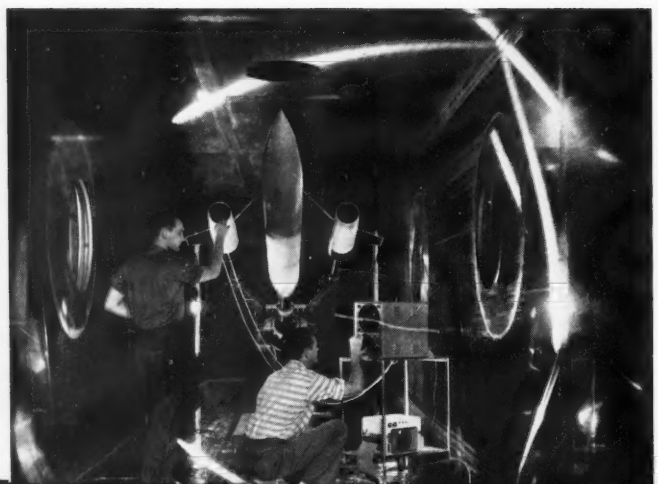




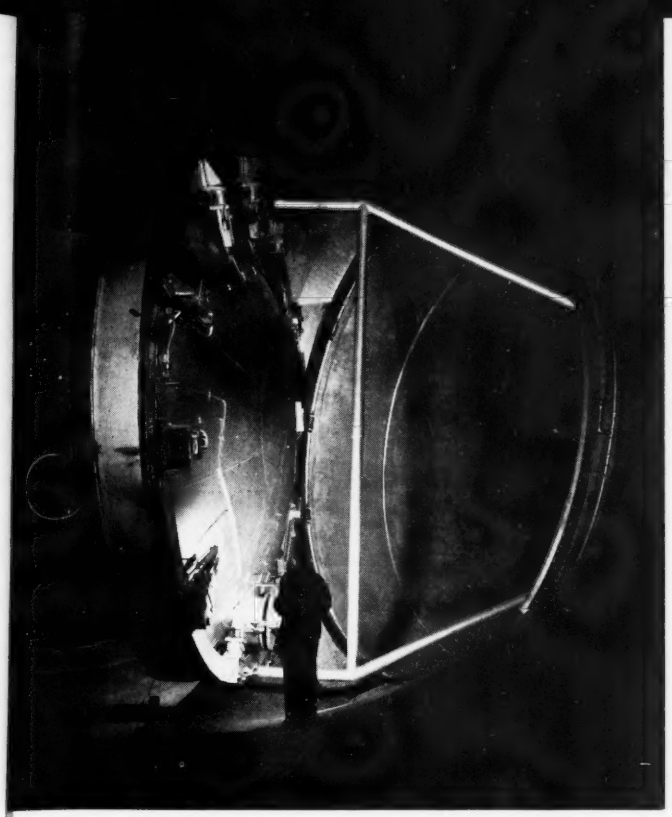
Bomarc ramjet engine is installed in altitude chamber for testing under temperature and pressure conditions simulating those at high altitudes.

Technician adjusts valves on rocket engine test stand in new rocket engine research facility. Research engine is mounted vertically within the tubular frame.

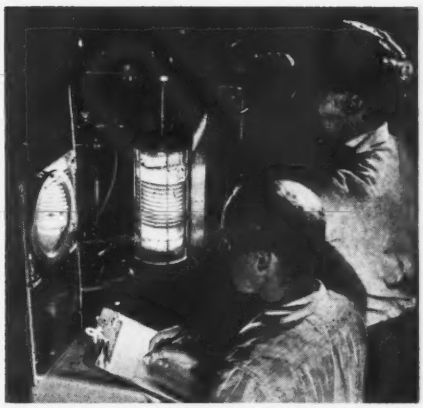
NACA research scientist visually checks experimental vehicle in a small supersonic wind tunnel. Model is strut-mounted on mechanism which can vary angle of attack.



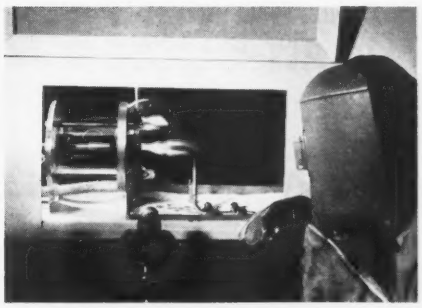
Experimental model is prepared for testing in 10 by 10 ft supersonic wind tunnel, which permits testing of engines and components at speeds of 1500 to 2500 mph at simulated altitudes up to 30 miles.



This 24 ft diam swinging valve is one of key elements of 10 by 10 ft wind tunnel. In one position, it seals off tunnel exhaust, making tunnel a closed circuit; in the other, it acts as seal across tunnel, leaving exhaust open.

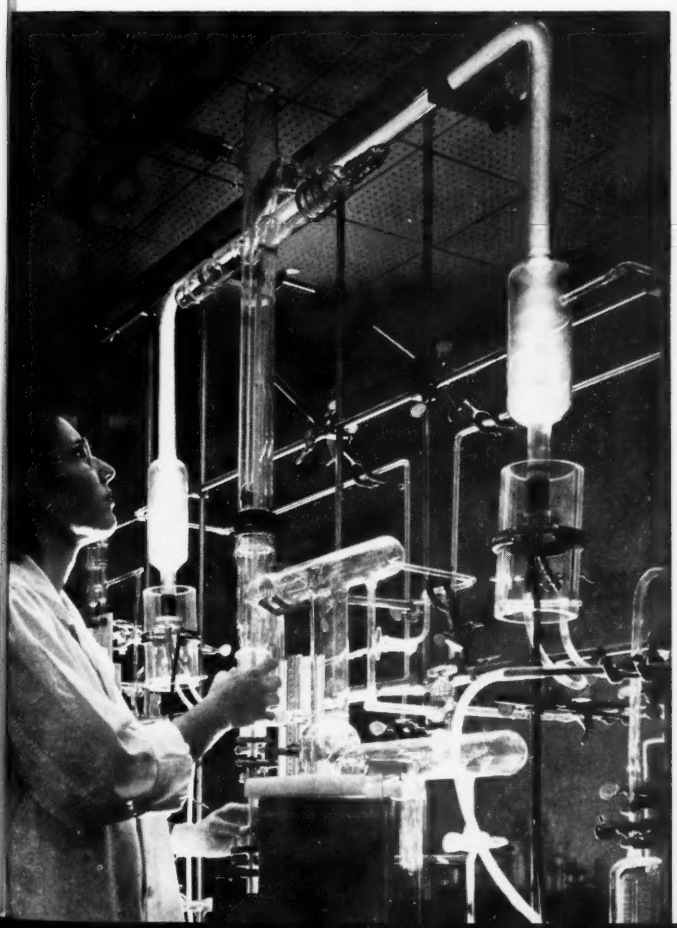


Induction furnace is operated as part of study of materials for use in design of nuclear powerplants and in nose cones of hypersonic missiles.



Plasma jet of ionized air, hotter than surface of sun, disintegrates small aircraft model. This device is useful in study of aerodynamic heating problems.

Nose shapes and surface finishes affect skin temperature and boundary layer transition on hypersonic missiles. Here, Lewis engineers check design of a semi-blunted model made of nickel and Inconel.



Lewis scientist compares materials under a barrage of atoms to determine which are more resistant to atomic attack and more useful in the manufacture of rockets and guided missiles.

Base for solar flare program on San Nicolas Island. Telemetry station is in trailer prepared by NRL in Washington and shipped to island by LCT from Point Mugu. Naval Missile Test Center prepared launching site, communications hut, and quonset hut for rocket assembly.

Push-button rocketry

Navy IGY rockets measure X-ray emission of solar flares in series of hurry-up firings from San Nicolas Island, off California Coast

Robert A. Kaplan of NRL checks radio detectors aboard trailer and communicates with solar observatories through radio link.

SAN NICOLAS ISLAND, 60 miles off the California Coast on the Naval Missile Test Center, Point Mugu Range, is the site of the first program of upper air research utilizing "push-button rocketry." On a small concrete pad overlooking the ocean, an armed, instrumented rocket is in constant readiness to be fired into the ionosphere at the first appearance of a solar flare. Thirteen two-stage Nike-Deacon rockets have already been launched in this IGY study of the ultraviolet and X-ray emissions of solar flares.

The experiments are being conducted by scientists and engineers of the Naval Research Laboratory's Optics Div. under the direction of Herbert Friedman, project leader, and Talbot A. Chubb, James E. Kupperian Jr. and John C. Lindsay. Responsibility for the rocketry phase of the program is contracted to Cooper Development Co., Monrovia, Calif.

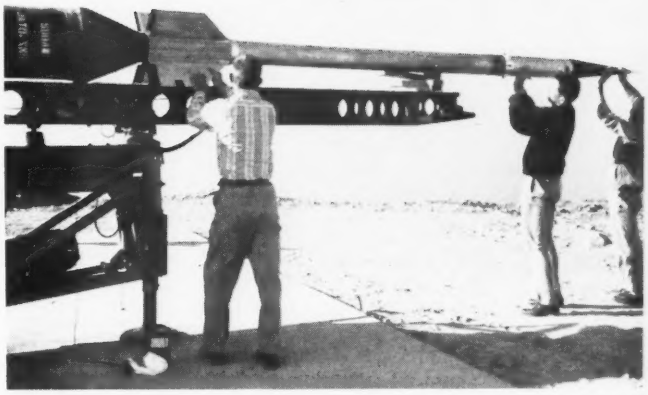
A typical solar flare flashes to peak brilliance in a matter of minutes and then fades away in about half an hour. If the flare is large enough, violent ionospheric disturbances are produced, the most familiar being fadeout of short wave transmissions. Because flares are short-lived, and occur infrequently, each rocket must be launched within a matter of minutes of the birth of the flare. De-

cisions to fire have been based on notifications of flare observations via teletype and radio links from three cooperating solar observatories on Mount Wilson, Calif., Sacramento Peak, N. M. and Climax, Colo., plus radio fadeout detection at the launching site.

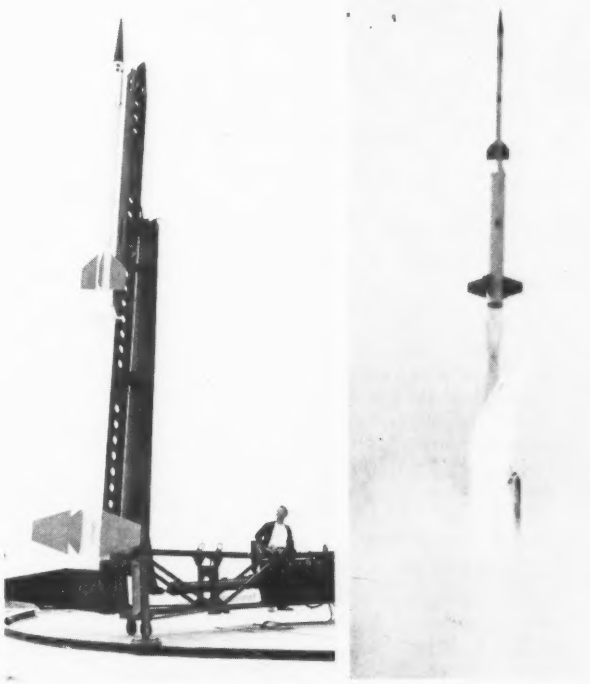
In the Nike-Deacon system, known as the Dan, both rockets use solid propellants. The Deacon, 6 in. diam, 14 ft long, and weighing 200 lb, rests on the half-ton Nike booster with the throat of its exhaust nozzle fitting snugly into a conical transition piece fastened to the top of the booster casing. As soon as the booster burns out, inertial drag separates it from the lighter Deacon, which coasts for 12 sec to an altitude of about 40,000 ft before firing. The Deacon, carrying a 30-lb payload of instruments, is rated to reach an altitude of 350,000 ft.

In readiness for firing, the two-stage rocket rests on a launching rail elevated to an angle of 85 deg. After firing, the booster describes a parabolic trajectory, impacting a mile or two down range. The Deacon's horizontal velocity component carries it about 30 miles out to sea. Although the Point Mugu Range is restricted to shipping, 30 sec are allowed before firing to permit a rapid radar search of the area to detect the presence of any stray vessels on the firing line. If no halt is ordered by the radar crew within 30 sec, instrumentation is energized and the rocket launched after a 30-sec allowance for warm-up of the electronics.

In a series of 13 firings completed during the first three months of IGY, eight rockets attained altitudes within 20 per cent of the expected value. Three rockets exceeded 400,000 ft. All eight of the successful shoots penetrated the D-region of the ionosphere, which is where solar flare radiations interact with the atmosphere. Each rocket carried photon counters and ionization chambers sensitive to ultraviolet X-ray wave lengths. During flight, signals from these tubes were telemetered continuously on four channels.



NRL scientists screw instrument section and nose cone onto Deacon rocket bottle prior to launching.



Nike-Deacon at 85 deg angle on launcher (left) and, at right, taking off in search of solar flare radiation.

Provided Data on Solar Emissions

The opening rocket shoot of the U. S. IGY program took place last July 1 at San Nicolas Island. It provided background data on solar emissions in the absence of flares. Of the remaining dozen rockets, ten were fired in flares and two more were used as test rounds after modifications to the rocketry and instrumentation. Each flare rocket was launched exactly 60 sec after the decision to shoot, based on observatory and radio fadeout information. In addition, two rockets were fired successively from the one launcher within 12 min of each other during the course of a single flare.

Except for the first few (CONTINUED ON PAGE 80)

missile market

Financial news of the rocket and guided missile industry

BY ROBERT H. KENMORE

WITH DECEMBER a month of indecision and slow markets, no significant changes were registered by either the missile index or the Dow-Jones Industrial Average.

When all economic statistics have been compiled, the records will show that 1957 was an outstandingly good year, in many respects the best ever. But the average investor will be unimpressed by the new all-time highs in gross national product, personal income, employment, etc. He won't even total up his dividend receipts which, most probably, also hit a new high. Depending on his disposition, the investor will take a grim or a sad look at the shrunken value of his stock portfolio and conclude that 1957 was a pretty miserable year.

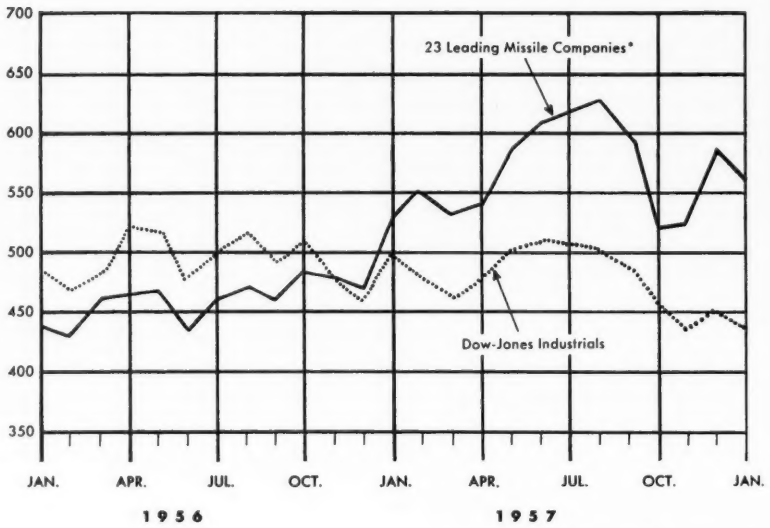
For investors in the missile industry, however, things have not been quite so black. While many issues did end the year with declines (see evaluation of missile index components below), many profit opportunities were available as the news spotlight fell on the industry. More than any other group of companies, missile firms were repeatedly examined and analyzed, and a heightened awareness of their investment potential was manifested by the general investing public.

The real accomplishments of 1957 were unfortunately obscured by the fact that the U. S. suffered from an advanced case of boom psychology. Prosperity had become such a part of the American way of life that new records were expected regularly, and any temporary downturn brought cries of disaster.

Market Reflected Shift

The quick shift in sentiment was clear in the stock market, which pretty accurately reflected business opinion throughout 1957. In January and February, when the first pessimists spoke up, the Dow-Jones Industrial Average fell 44 points to 455. Later, when it became apparent that this initial pessimism was overdone, the market rose again to a July peak closely approximating 1956's all-time highs. Thereafter, with the first signs of trouble, the Dow came down more than 100 points to a new 1957 low. At year's end it was backing and filling as investors tried to make up their minds about what 1958 would bring.

THE MARKET AT A GLANCE



*Index compiled June, 1955

	January 1958	December 1957	% Change	January 1957	% Change
Dow-Jones Industrials	439	450	−2.4	499	−12.0
23 Missile Companies	563	578	−2.6	528	+6.6

The missile index showed even wider swings during the year. Of greatest significance, however, was that while it started 1957 with a scant 29-point edge on the Dow-Jones, it entered 1958 with a substantial lead of 124 points. In other words, its performance during the year was approximately 100 points better than that of the Dow—a rather impressive margin.

At the beginning of 1957, businessmen and economists were unanimous about the outlook: The first six months would be good, but then there might be trouble. At the beginning of 1958, there is unanimity again, but with a twist: The next year will see a sharp dip during the first half, followed by an upturn in the last six months, helped along by big increases in government spending.

As we enter 1958, the American economy is somewhat wobbly. Car loadings and steel production are way down; unemployment, negligible in recent years, has been rising steadily and is at its highest point in eight years; hundreds of stocks, including industry leaders, are making new lows day after day. Investors are switching to the bond market with unrestrained enthusiasm, gladly forsaking the opportunity in stocks for the so-called safety of bonds. And yet, if we examine closely the current period of "recession," we find it is probably the most gold-plated down-turn we have ever been in.

Industry Will Gain in Stature

Recent market letters indicate most security analysts are bearish about investing in the missile industry. This is good. *The only time one can buy stocks cheaply is when nobody else likes them.* Thus 1958 could be a year of great opportunity. We think the missile industry will continue to gain in stature as an industry in the year that lies ahead.

Already one large brokerage house has compiled its own "missile index" to help compare industry performance

(CONTINUED ON PAGE 92)

Through this rugged but sensitive vibration pickup, the smallest hint of unbalance in a turbojet or turboprop engine is detected and fed to a transistorized amplifier... and then to a signal light and meter ...providing advance indication of irregular or inefficient operation.

Read the complete story in Bulletin CEC 3011-X3.

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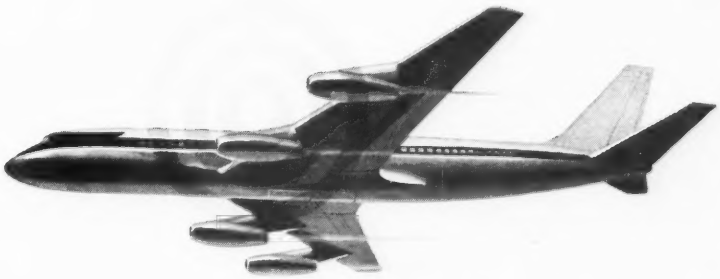
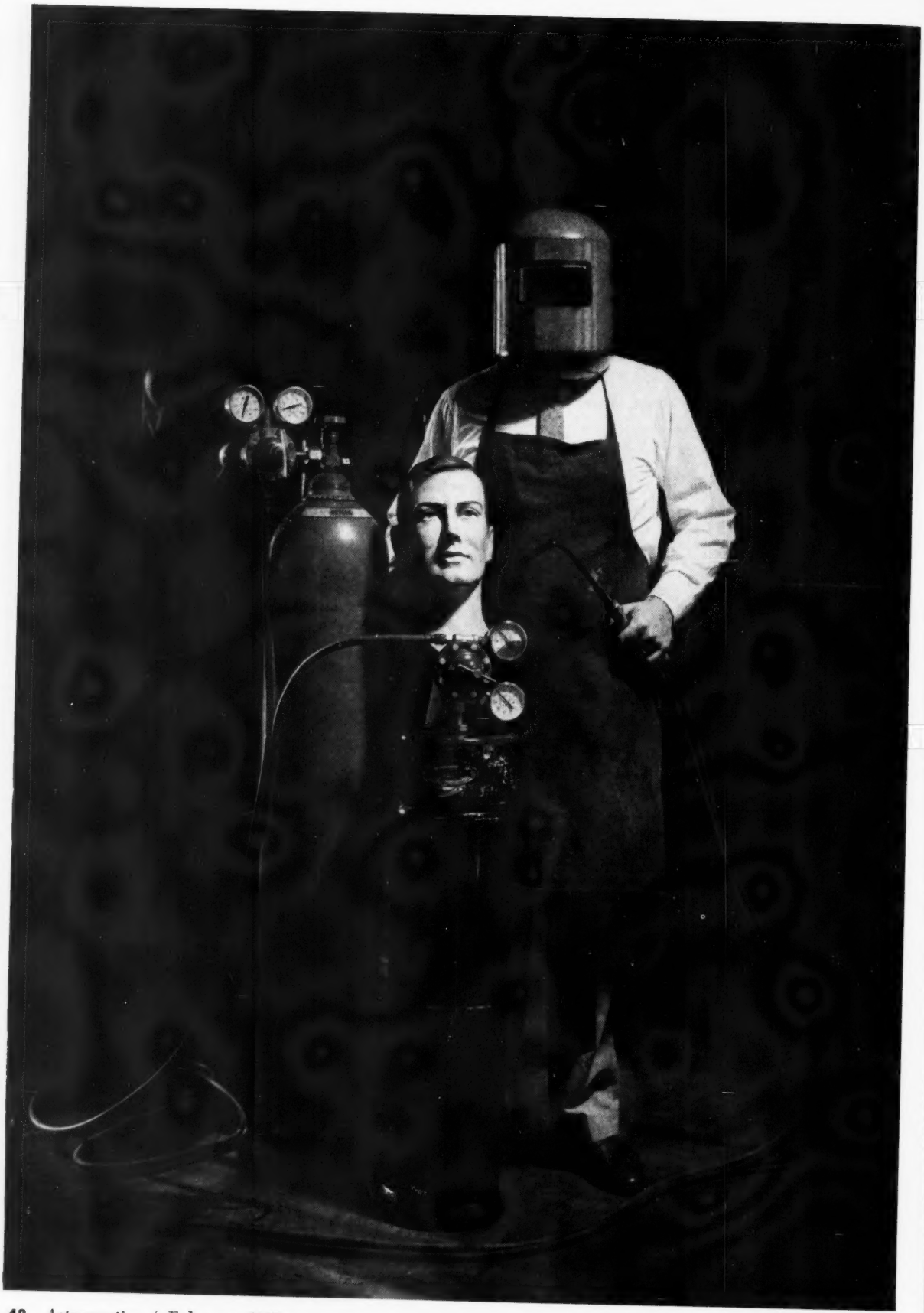




Is it possible to build a **MAN?**

"Theoretically, yes," said the scientist. "Or a reasonably remarkable imitation—a kind of mechanical analogue. Call it a habit machine, a mechanism operating according to the laws of the conditioned reflex."

You mean that you could actually build a mechanical mind? One that would exhibit emotions —such as love, fear, anger, loyalty?

"We're doing something like that now in advanced missile development," the scientist replied. "In a limited, highly specialized way, of course."

"Take the 'pilot' that is being developed for the big long-range missile. *He* has a wonderful memory, and can solve many complex navigational problems in a flash. *He* loves perfection, and actually becomes highly excited when *he* gets off course. *He's* a tough-skinned character, impervious to the cold at several hundred miles altitude and the incredible heat at re-entry. And *his* loyalty is heroic. *His* life is a single mission, the mission *his* whole life... and maybe ours, too. *He's* a pretty important *fellow.*"

What about the complete man-made Man? What would that entail?

"A mechanism the size of the capitol in Washington, and the best scientific resources in the world. But it could be done. You see, it's only a question of how physical matter is organized. As a great biophysicist explained, 'If material is organized in a certain way, it will walk like a man. If it is organized in another way, it will fly like a missile.'"

Still, wouldn't there be something missing in the complete man-made Man—something very important?

"Yes," said the scientist. "A soul."

MARTIN

BALTIMORE·DENVER·ORLANDO

Life in Sputnik

(CONTINUED FROM PAGE 39)

cosmic particles? So far, there is no full answer. The published data speak of great difficulty in protection. It is effected on the same principle as protection from nuclear radiation. The presence of nuclei of heavy elements in cosmic particles complicates this task. Even the most powerful artificial sources in laboratories have not yet created particles with energies which could be compared to the energy of heavy nuclei of cosmic radiation. The launching of a sputnik with an animal will enable scientists to obtain highly important data on this problem.

The task of science is not only to determine cosmic ray intensity and the amount of penetration the tissues of an organism can withstand, but also to establish safe exposure times. It is known that the so-called latent period, i.e., the time from the moment cosmic particles enter the organism to the moment their action becomes evident, can last for weeks and even months. This necessitates prolonged observation of the organism after it has been subjected to the influence of such particles. For this purpose, satellite-borne animals will have to be brought back to earth for subsequent study.

The second Soviet artificial earth satellite is equipped with instruments for measuring all the above-mentioned radiational influences of cosmic space, short wave ultraviolet and X-ray radiation of the sun, and cosmic rays.

There is also the so-called meteorite danger. It is known that more than a ton of meteorites penetrates the atmosphere of our planet daily. Possessing huge velocities of 30–50 and even more km per sec, they are heated by friction with the air and burn up in the upper layers of the atmosphere. As a rule, meteorites do not penetrate to altitudes lower than 70–100 km. The higher the altitude, however, the greater the possibility that a satellite will encounter meteorites. It is important to establish to what extent this depends on orbital altitude, season of the year, etc.

The first weeks of flight by Sputnik I show it was not subjected to the action of meteorites of destructive force. Protection against particles which might make a hole in a satellite can be provided either by arranging a metal screen to absorb the energy of these particles at some distance from the shell of the vehicle, or by diverting the particles by electromagnetic radiation or other means.

Since living space in a satellite is very limited, the mobility of the animals it contains must also be re-

stricted. Such restriction causes changes in the physiological functions of the organism. For example, we know that, when a man is confined to bed for a long time, it is often necessary to take measures to prevent hemostasis, bedsores, etc. Naturally, such measures must also be taken for animals in a satellite.

A satellite has to be accelerated to about 8000 m per sec. Since such speed has to be attained soon after launching, prolonged and intense acceleration is necessary. The effects of acceleration on the organisms of animals and humans have been studied intensively in recent years.

May Cause Unconsciousness

If acceleration acts vertically, from foot to head, a redistribution of the entire mass of blood in the organism may result, with an overabundance in the lower part of the body and a shortage in the upper part. At the time of considerable intensity of acceleration, the usual level of blood circulation in the cerebrum may be reduced, leading to a derangement of the central nervous system, and even to loss of consciousness.

If acceleration acts horizontally, man's body can withstand it much better. Special suits which tightly grip certain parts of the body, and do not allow blood to accumulate, help to fight the overload. These questions also are being studied in experiments with animals.

We know that uniform speed does not exert any effect on the organism. But the greater the speed of movement, the harder it becomes for man to orient himself in space. At a certain speed, man's sensory organs are unable to provide the brain with exhaustive information because of the rapid succession and incompleteness of his sensations. Therefore, space flight will be controlled primarily from ground stations with the help of electronic computers in accordance with a program drawn up in advance. Thus, astronauts will be free of direct control of their flight, since this is literally beyond man's capability.

Let us proceed to the question of the absence of the force of gravity, or zero-g, which cosmic travelers will inevitably encounter. The effects of zero-g on both animals and man has been studied in recent years. Although these observations pertain to brief instances of zero-g, lasting no more than a few seconds, there is no doubt that the influence of prolonged zero-g may prove to be entirely different. This is what must be determined through the use of satellites which carry animals.

Derangement in the coordination of motion has already been established in weightlessness experiments with animals and man. At the same time, these experiments have revealed the remarkable ability of the nervous system to adapt itself quite quickly to new conditions. After a certain number of experiments, coordination of motions under zero-g conditions begins to improve considerably.

Weightlessness undoubtedly also influences such functions of the organism as respiration, blood circulation, body temperature, etc. We know that the weight of the blood is one factor in the regulation of blood circulation. The exclusion of this factor under zero-g conditions may affect the distribution of blood in various parts of the organism. Observation shows that zero-g causes a certain lowering of blood pressure.

Under the effect of acceleration, the gas exchange rate in the organism increases, and consumption of oxygen and emission of carbon dioxide rise several times. Under zero-g conditions, we may expect a lowering of the gas exchange rate, at least after the organism becomes adapted to the absence of gravity. These data are important for assuring oxygen supply to animals and determining the capacities of air-conditioning devices. Naturally, experiments with animals in a sputnik will be quite fruitful in this respect.

There is another important reason for using animal-carrying satellites, and that is to protect future astronauts. Since unforeseen circumstances may compel space ship crew members to leave the vehicle, it is necessary to conduct experiments of this type with animals. This means that eventually, it will also be highly desirable to bring the animals back after a satellite finishes traveling along its orbit, so that their condition may be studied.

The distance of the orbit from the earth is of significance for flights of sputniks without animals. The greater the distance, the longer the satellite will live. But what about animal-carrying sputniks? Is there any reason for seeking to reduce the distance of the orbit from the earth? It turns out that this is unnecessary, since at all altitudes where satellites can orbit, essentially the same conditions—true space conditions—exist.

Is Felt at 8–9 Km

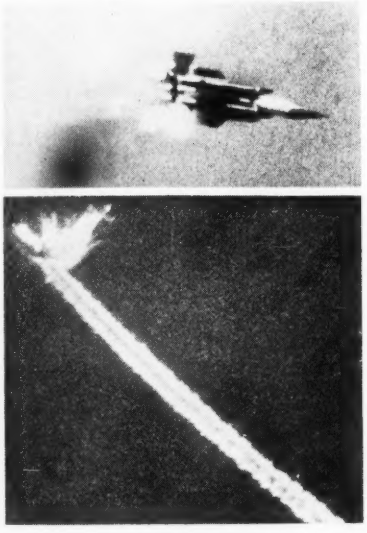
For example, insufficient barometric pressure makes itself felt at an altitude of 8–9 km, and the so-called time reserve, that is, the period in which man retains consciousness after his oxygen supply is exhausted, becomes very small at 19–20 km and beyond that point hardly depends on further increases in altitude.

At an altitude of 19.2 km, it is necessary to take protective measures against boiling of liquids in an organism. The borderline for absorption of heavy cosmic ray particles is around 36–37 km. The region where the ultraviolet portion of the solar spectrum is equivalent to that in interplanetary space starts at 42–43 km. Meteorites usually burn up at altitudes of about 100 km. The propagation of sound becomes impossible at or above altitudes of 122 km because here the distance between air molecules becomes essentially the same as the length of soundwaves man can hear. And, at approximately this altitude, intensity of cosmic ray particles begins to rise sharply.

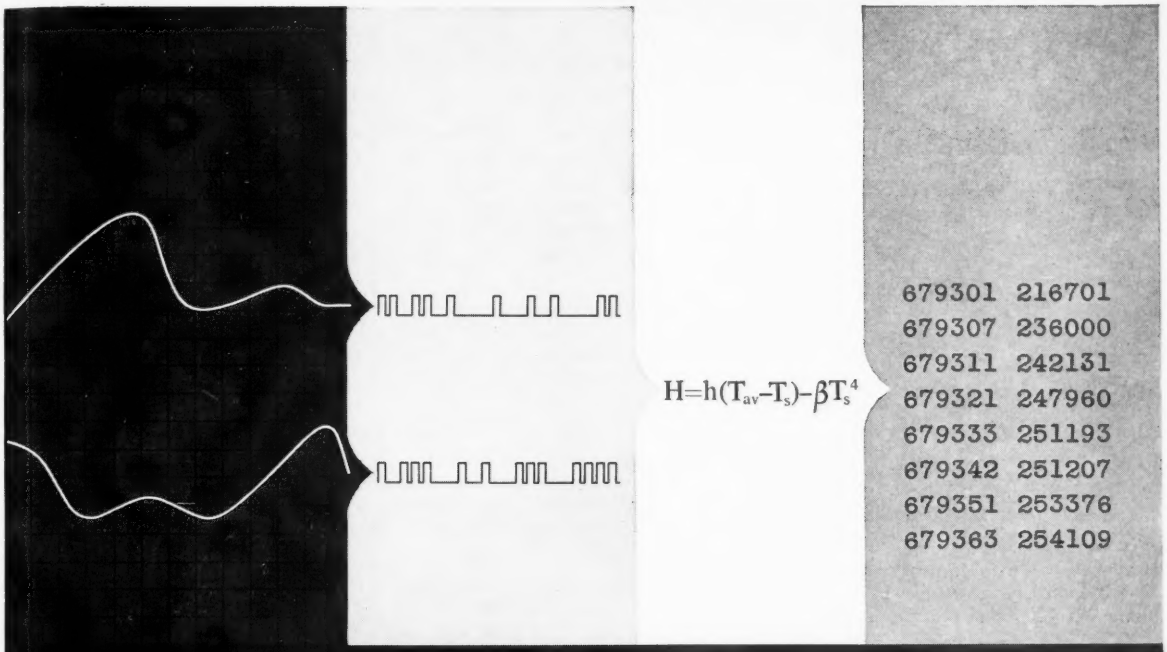
Thus it can be seen that the region where satellites can exist for long periods is essentially that of empty space.

We live in times of rapid, ever-accelerating development of science and technology. Satellite launchings signify the advent of a new era in the history of science and in man's mastery of cosmic space. It is our belief that, within the next five to 10 years, the flight of man into cosmic space, possibly with landings on other planets of our solar system, will become a reality.

On Target



British ground-to-air Thunderbird missile is shown in successful test above Woomera weapons range in Australia. Although it carried no warhead, it destroyed an Australian-built Jindivik jet target aircraft which it struck amidship. In top photo, Thunderbird begins homing run on target. Above, moment of impact.



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Digital techniques employed in the design of the RW-300 computer have also been utilized by R-W systems engineers in the development of special-purpose digital instrumentation systems. Building blocks available for use in such systems include voltage-to-digital converters, electronic commutators, digital data recorders, data-handling links, and special equipment such as the RTD-3103 Range Time Decoder. Additional information on digital instrumentation systems is available on request.

people in the news

Von Braun Honored

Wernher von Braun (left) receives Huntsville Distinguished Citizen Award from Charles Shaver at annual dinner of Chamber of Commerce.

APPOINTMENTS

Vice Adm. Harry Sanders (USN-Ret.) has joined Chance Vought Aircraft, Inc., as staff engineer-missiles. In his new post, Adm. Sanders will direct preparation of training material designed to teach Navy submarine crews how to handle and operate the Regulus II missile.

Systems Corp. of America has been organized by **John L. Barnes,** former president of Systems Laboratories Corp. and vice-president of Systems Research Corp. (now Aeronutronics), as a consulting and research organization in the field of interplanetary travel and environmental measurements beyond the atmosphere. The new company will make its headquarters in West Los Angeles, Calif.

Ernst Steinhoff has been appointed associate technical director of Aerophysics Development Corp., a subsidiary of Curtiss-Wright Corp. In addition to his new duties, Dr. Steinhoff will continue as department manager of AF Missile Projects at Aerophysics.

Richard H. Braun has been named director of the Physical Research Laboratory of Fairchild Guided Missiles Div. **Walter F. Grasse** and **Theodor Rakula,** who had been working with Dr. Braun in the company's Alexandria, Va., office in a surface-to-air missile study, have also joined the laboratory's staff.

George E. Thompson has been attached to the Reaction Motors, Inc., Washington, D. C., office as product engineer.

E. A. Bellande has been elected vice-chairman of the board of Garrett Corp. A vice-president since 1946, Bellande joined the company as assistant to the president in 1943.

Becco Chemical Div., Food Machinery & Chemical Corp., has promoted **Dewey H. Nelson** to assistant manager. He will continue as sales manager of the division, a post he had held since November, 1956.

Richard H. Graham, head of Lockheed Missile Systems Div.'s nuclear engineering and development section, has been named to the post of technical secretary of the Atomic Energy Commission's Advisory Committee on Reactor Safeguards.

Paul L. Davies, chairman and chief executive officer of Food Machinery & Chemical Corp., has been elected to the board of International Business Machines Corp.

Clary Corp. has established a central Quality Control Dept., to be headed by **Louis M. Buhler.**

Six new scientists and engineers have been added to the staff of Solar Aircraft Co.'s missile engineering group. They are: **Karl F. Greil,** head of preliminary design; **Frederick W. Ross,** chief of aerodynamics; **Laurence H. Cherry,** chief of research and development planning; **Morris Kaswen,** chief of guidance and control; **M. C. Towns Jr.,** chief of propulsion; and **Daniel H. Driscoll Jr.,** senior propulsion engineer, missiles.

R. T. Silberman, vice-president of Cohu Electronics, has been named president of the company's Kin Tel Div.

Villiers **Spencer**

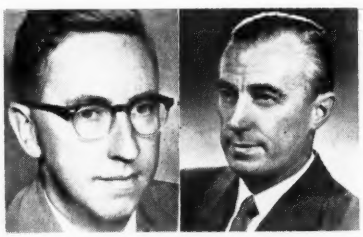
Charles Villiers, a former President of the AMERICAN ROCKET SOCIETY, has joined the Electronics Dept. of Hamilton Standard, Div. of United Aircraft Corp. as project engineer. He was most recently associated with the University of California Radiation Laboratory and was previously with the Eclipse Div. of Bendix Aviation and the North American Aviation Aerophysics Laboratory.

Percy L. Spencer has been elected senior vice-president of Raytheon Mfg. Co. He is head of the company's Microwave and Power Tube Div.

Adm. James F. Byrne (USN-Ret.) has been appointed director of material for Norden Laboratories Div. of Norden-Ketay Corp. He was formerly assistant chief engineer, field operations, Chrysler Missile Operations.

Ernst Weber has been elected president of the Polytechnic Institute of Brooklyn. A pioneer in high frequency electronic research, Dr. Weber had been serving as acting president since last July. He was recently named to the Army Scientific Advisory Panel.

Donald C. McDonald has rejoined Cook Electric Co. as director of product engineering after a year with Bendix Aviation's Bendix-Friez Div. He was previously with Cook Research Laboratories from 1950 to 1956.



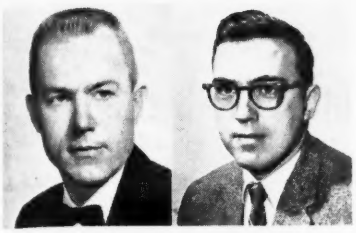
McDonald **Hull**

Harvard L. Hull has resigned as vice-president of Litton Industries to become president of the Nucledyne Corp., a subsidiary of Cook Electric Co. Prior to joining Litton in 1956, Dr. Hull was president of Farnsworth Electronics Co.

S. J. Womack has been named assistant general manager of the Nuclear Fuels Div. of Olin Mathieson Chemical Corp. He was formerly general manager of the Chemical and Industrial Mfg. Div. of O-M International Corp.

John A. Thayer has been named Northwest district manager for Sundstrand Aircraft Service Corp., a subsidiary of Sundstrand Machine Tool Co. He will work out of a new district office in Seattle, Wash.

Stuart G. McGriff has been named product manager, fuels and propellants, Callery Chemical Co., and



Willard McGriff

Gradon F. Willard has been appointed production manager of the company's Muskogee Div.

Carlos H. Elmer has joined Traid Corp. as a field engineer specializing in photographic instrumentation uses in rocket and missile testing.

Arthur R. Collins, since 1948 general manager of the South Wind Div. of Stewart-Warner Corp., has been elected a vice-president of the corporation.

HONORS

Wernher von Braun, director of development operations, Army Ballistic Missile Agency, Huntsville, Ala., and a Director of the AMERICAN ROCKET SOCIETY, was honored by his fellow citizens of that city at the annual dinner of the Chamber of Commerce. Dr. Von Braun received the Huntsville Distinguished Citizen Award, which cited him for his leadership of "the finest missile research team in the Western World."

Milton Greenberg, director, Geophysics Research Directorate, AF Cambridge Research Center, has been awarded the Medal for Exceptional Civilian Service by the Secretary of the Air Force. He was cited for the important role he played in developing an organization which has earned "an outstanding reputation for scientific and technological achievement, and has made important contributions to the AF research and development program."

Edward C. Wells, vice-president, engineering, Boeing Airplane Co., has been elected president of the Institute of the Aeronautical Sciences for 1958. He succeeds Mundy I. Peale, president of Republic Aviation Corp.

George M. Bunker, president of The Martin Co., has been elected chairman of the board of governors of the Aircraft Industries Assn. for 1958. He succeeds Whitley C. Collins, president of Northrop Aircraft, Inc.

Patrick E. Haggerty, executive vice-president of Texas Instruments, Inc., has been elected a Fellow of the Institute of Radio Engineers.

on the calendar

1958

Feb. 3–4	Symposium on "Flight Control—Panel Integration," co-sponsored by USAF, Flight Control Lab., WADC, and Cook Research Laboratories, Biltmore Hotel, Dayton, Ohio.
Feb. 4–6	Thirteenth Annual Technical and Management Conference, Reinforced Plastics Div., The Society of the Plastics Industry, Inc., Edgewater Beach Hotel, Chicago.
Feb. 6, 13, 20, 27	Gas Dynamics Colloquium, Technological Institute, Northwestern U., Evanston, Ill.
Feb. 13–15	Spring Meeting of National Society of Professional Engineers, Michigan State U., East Lansing, Mich.
Feb. 17	"IGY-Technology at the Threshold" will be theme of 1958 Conference of ASME, Hotel Huntington-Sheraton, Pasadena, Calif.
Feb. 26–27	Air Force Assn.'s Third Annual Jet Age Conference and Guided Missile Symposium, Washington, D.C.
March 3–6	International Gas Turbine Power Division Conference and Exhibit, ASME, Washington, D.C.
March 16–21	1958 Nuclear Congress, Chicago, Ill.
March 17–20	**American Rocket Society—ASME Aviation Div. Conference, Statler-Hilton Hotel, Dallas, Tex.**
March 17–21	Fourth Nuclear Engineering and Science Conference of the 1958 Nuclear Congress, Chicago Inter-National Amphitheatre, Ill.
March 17–21	14th Annual Conference of National Association of Corrosion Engineers, Civic Auditorium, San Francisco.
March 18–19	Conference on Extremely High Temperatures, AF Cambridge Research Center, Bedford, Mass.
March 18–19	Inter-Service and Industry Symposium on Guided Missile Training Equipment, Naval Ordnance Lab., White Oak, Silver Spring, Md.
March 24–27	IRE National Convention, NYC.
April 22–24	1958 Electronic Components Conference, sponsored by IRE, AIEE, EIA, Ambassador Hotel, Los Angeles.
April 27–May 1	60th Annual Meeting of American Ceramic Society, Penn-Sheraton Hotel, Pittsburgh, Pa.
May 4–7	Fourth National Instrumentation Flight Test Symposium of ISA, Park Sheraton Hotel, NYC.
June 2–4	**National Telemetering Conference under auspices of ARS, IAS, AIEE, ISA, Lord Baltimore Hotel, Baltimore, Md.**
June 9–11	**ARS Semi-Annual Meeting, Hotel Statler, Los Angeles, Calif.**
June 16–18	Second National Convention on Military Electronics, sponsored by IRE, Sheraton Park Hotel, Washington, D. C.
June 19–21	**Heat Transfer and Fluid Mechanics Institute Meeting, University of California, Berkeley.**
Aug. 24–30	**Ninth Annual Congress of International Astronautical Federation, Amsterdam, The Netherlands.**
Sept. 15–18	**ARS Meeting, Hotel Statler, Detroit, Mich.**
Sept. 22–24	IRE National Symposium on Telemetering will include "Space Electronics," Ambassador Hotel, Bal Harbour, Miami Beach, Fla.
Sept. 24–25	National Electronics Conference, sponsored by IRE, AIE, EIA, Hotel Sherman, Chicago.
Sept. 29–30	Basic Science Div., American Ceramic Society, Wright-Patterson AFB, Dayton, Ohio.
Dec. 1–5	**ARS 13th Annual Meeting, New York, N. Y.**

DEATHS

Wilbur L. Webb, general manager of the Missile Section of Bendix Aviation Corp., died Dec. 23 in South Bend, Ind., after a two-year illness. A pioneer in electronics, Mr. Webb designed the automatic radio direction finder which has become a standard aircraft navigation aid. He had been with Bendix since 1936, and in 1952 was named head of the new operation in Mishawaka, Ind., established by Bendix to build the Talos missile for the Navy. An ARS member, Mr. Webb also served on the guided missile committees of several other professional and engineering societies.

ASME Conference To Spotlight IGY

"International Geophysical Year: Technology at the Threshold" is the theme for the 1958 Conference of the Professional Divs. of ASME, set for Feb. 17 at the Hotel Huntington-Sheraton, Pasadena, Calif. Tentative topics and speakers include Radio Astronomy in IGY, John G. Bolton, Cal Tech; Satellite Instrumentation and Tracking, H. L. Richter, Cal Tech; Environment of a Satellite Re-entry Body, Robert Bromberg, Ramo-Wooldridge; and Energy Sources of the Future, R. C. Allis-Chalmers Mfg. Co.

ARS news

Field Trips, Nuclear Propulsion Session Highlight ARS-ASME Dallas Meeting March 17-20

A 24-SESSION program has been planned for the ARS-ASME Joint Aviation Conference scheduled for the Statler-Hilton Hotel in Dallas March 17–20. George H. Craig of Convair, ARS General Chairman for the meeting, also announces that field trips are planned to Phillips Petroleum Co., Chance Vought Aircraft, Convair and Texas Instruments Co. installations during the meeting.

The complete program will be carried in the March ASTRONAUTICS.

The tentative lineup of sessions:

Monday, March 17

A.M. Solid Rockets
Local Carriers
Aircraft Mechanisms

P.M. Solid Rocket Installations
Local Carriers
Aircraft Mechanisms

Tuesday, March 18

A.M. Liquid Rocket Installations
Guided Missile Instrumentation Panel
Maintenance of Major Airlines
Human Factors in Engineering
Hydraulics and Accessories

P.M. Medical Problems in Space Flight
New Materials and Processes
Passenger Comfort
Bearings and Lubrication
The Forward Look

Wednesday, March 19

A.M. Nuclear Propulsion
Drones
Elevated Temperature Test Facilities
Data Acquisition and Processing

P.M. Ramjet Installations
Space Flight
Elevated Temperature Test Facilities
Data Acquisition and Processing

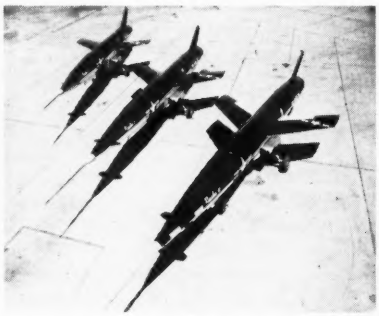
Thursday, March 20

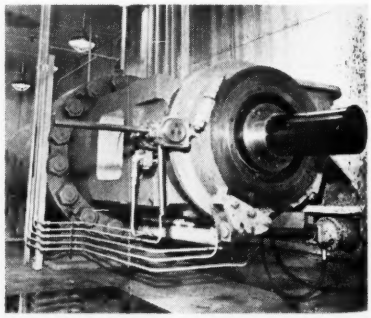
Field Trips

Outstanding speakers have been invited for luncheons to be held during the meeting and for the meeting banquet, which will take place on March 18.

Bird's-eye view of Dallas, scene of the ARS-ASME Joint Aviation Conference.

Statler Hilton Hotel in Dallas, where the meeting will be held.





Visitors at the meeting will have an opportunity to inspect (left to right) Convair's Fort Worth Div.; Chance Vought's Regulus II missiles, built in Dallas; and equipment like this extruder at Phillips Petroleum's Rocket Fuels Div. at McGregor, Tex.

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Brown Heads ARS Guidance Committee

Lawrence S. Brown has been named Chairman of the ARS Instrumentation and Guidance Committee, succeeding John J. Burke of Hallamore Electronics Co. Mr. Brown is manager of the Missile Development Div., Ford Instrument Co. Div. of Sperry Rand Corp., Long Island City, N. Y.

L. S. Brown

A graduate of the U. S. Naval Academy, he joined Ford in 1934 after two years of fleet duty, serving as test and field engineer on naval fire equipment until 1940, when he was assigned to design engineering. In 1953 he joined Bulova Research and Development Laboratories as contract manager, later serving as sales manager. He rejoined Ford in 1954 as project engineer for Redstone guidance and control work on the staff of the president, and in 1956 was named manager of Ford's newly formed Missile Development Div.

SECTION NOTES

Detroit: Herbert L. Karsch of Aeronutronic Systems, Inc., director of Project Farside, was the guest speaker at the November meeting of the Detroit Section. He described the four-stage rocket used in the Eniwetok Atoll firings and pointed out that the 10 solid propellant rockets used in the vehicle were all standard rockets and represented well-known techniques. He also noted that the name of the project derives from one of the objectives of the AF research program—to fire a rocket around the far side of the moon. This is now under consideration, Karsch revealed, but it is a big job and the chances for failure on the try are high.

Before the well-attended meeting, guests were treated to a social mixer sponsored by Kelsey-Hayes Co. The meeting itself was held in the small auditorium of the Engineering Society of Detroit.

Herbert L. Karsch

Holloman: The regular monthly meeting of the Holloman Section was held at the Desert Aire Motor Hotel in Alamogordo, on Dec. 10. Attendance was 78 for the dinner, plus 10 more for the lecture.

President Knox Millsaps introduced the distinguished guest speaker, Clayton S. White, Rhodes Scholar, outstanding physician, Director of Research for the Lovelace Foundation, and research administrator with the Atomic Energy Commission. Dr. White spoke on the biological consequences of blast from high-yield nuclear detonations. He introduced his talk with a few remarks about the problems attending the age of missiles, rockets and satellites. He then discussed what happens when a pressure pulse passes through living tissue.

He pointed out that significant damage usually occurs when the pulse or wave passes over a boundary between tissues of different density, which have, of course, different mass per unit volume and hence respond to the shock at different rates, causing destructive separation of tissues. Also, he mentioned the injurious effect of expansion and contraction of air bubbles within the body and of lung damage due to compression. The audience was impressed with the fact that the human body can stand much greater direct blast effects than strong building structures, provided the body is not injured by the secondary blast effect of flying debris.

He concluded his lecture with slides prepared in his work with the AEC which show that a person in a below-ground level shelter could survive quite close to "ground zero."

Dr. Millsaps closed the meeting with the announcement that the January meeting would have as guest speaker William A. Fowler of the California Institute of Technology.

Maryland: The November meeting of the Maryland Section was held at Flight Refueling, Inc., located at Friendship Airport, Baltimore. Following a tour of the Flight Refueling facilities, during which the latest in-flight refueling systems were demonstrated, Brig. Gen. Marvin C. Demler, Deputy Commander for Research and Development, Air Research and Development Command, spoke to the nearly 100 people present on "Ground Support of Guided Missiles."

Ground control equipment for missiles, now amounting to about 70 per cent of a system's cost, controls the time between target location and launching, Gen. Demler said. Warning that minutes saved in firing time may be decisive, the general said "the U. S. is well ahead of Russia in standards of ground equipment."

June Meeting to Feature Experimental Engineering

Experimental engineering, which occupies the time and energy of a large percentage of scientists and engineers in the missile field, will take up an equally large portion of the ARS Semi-Annual Meeting scheduled for June 9–12, 1958, at the Hotel Statler in Los Angeles.

General Chairman of the Meeting is Charles A. Knight of the host Southern California Section, who announces that, besides the twelve technical sessions scheduled, plans call for the first ARS Western Regional Student Conference, some interesting field trips and illustrious speakers for luncheons and the banquet and for an exhibit adjacent to the meeting rooms.

Howard S. Seifert, newly appointed 1958 National Program Chairman, outlines the following tentative schedule of sessions, for which abstracts are invited right now. The deadline for reviewed and completed manuscripts is April 1.

1. Managing Experimental Engineering Projects
2. Static Test Instrumentation
3. Propellant Handling
4. Magnetohydrodynamics
5. Handling and Testing Rocket and Ramjet Engines
6. Operations Research Applied to Experimental Engineering
7. Bio-Satellites
8. Missile Launching and Salvage Operations
9. Guidance of Space Vehicles
10. What IGY Has Told Us About Space
11. Lunar and Cislunar Satellites
12. Rocket Engine Systems

Charles A. Knight
Meeting Chairman

Howard S. Seifert
Program Chairman

In emphasizing the need for better communication between the Air Force and civilian contractors, Gen. Demler pointed out that the success of America's guided missile program will largely depend on closer AF-industry teamwork. Because of the large portion of system costs now borne by ground support equipment, design engineers must learn to adapt existing commercial designs to military needs, rather than waste time and money in duplication for ground support equipment. ARDC provides classified information on AF requirements "five years ahead of time" to interested contractors, the general noted, in urging industry to take advantage of AF assistance in standardizing designs through active use of these planning documents.

The meeting ended with a long and enlightening question-and-answer period.

National Capital: Dan Kimball, president of Aerojet-General Corp., lashed out at Defense Secretary Neil McElroy's announced plan to establish a new Advanced Research Agency within DOD to control anti-missile missiles, space flight and other advanced R&D programs, in an address delivered at the December meeting of the Section.

Kimball hit the double management which would result from such an agency, pointing out that it would result in inefficiency and confusion. "These programs," he told the well-attended meeting, "are clearly military, and the problem of making them operational belongs to the services. . . Any agency which would try to supervise all these phases of missile development would only introduce excessive costs, unnecessary delays and inferior end products from the operational point of view.

"What we need is not so much another high level organization as a new kind of organization at high level—an organization which would simplify, not duplicate, the task of reaching an effective solution to our missile problems."

Philadelphia: The Philadelphia Section has embarked on a very ambitious program of meetings under the theme of "Rockets and Guided Missiles—Present State of the Art." The series will consist of seven lectures, covering aerodynamics, propulsion, guidance, structures, systems, high-altitude vehicles and space flight.

Bonney **Stehling**

The first two lectures have already been given. In November, A. E. Bonney, chief of aerodynamics at the Applied Physics Laboratory, the Johns Hopkins University, discussed "Supersonic Aerodynamics," while at the December meeting, Kurt Stehling, head of the Vanguard Rocket Section, Naval Research Laboratory, spoke on "Rocket Propulsion." Both meetings drew audiences of about 50 people.

Sacramento: A recent dinner meeting of the Section was attended by approximately 65 members and guests. Special guests of the Section for the meeting were four distinguished experts from the Army Ballistic Missile Agency at Huntsville—Hermann Oberth, James B. Bramlet, Leland F. Bellew and H. Hoeppner.

Featured speaker at the meeting was Richard Canright, a missile powerplant expert now with Douglas Aircraft Co. at Santa Monica, who read, because of security restrictions, a detailed and enlightening paper on the Nike-Ajax system, describing its inception, development, production and present day tactical use. Slides and a sound movie were included in the presentation. A brief question-and-answer period concluded the meeting.

Southern California: An open-

house meeting of the Section in December at the Los Angeles High School drew an audience of over 500 members and guests. The progress of the U. S. and U.S.S.R. toward the exploration of space was discussed by a distinguished panel: Joseph Krieger, Rand Corp.; W. H. Pickering, director of the Jet Propulsion Laboratory; and John L. Barnes, president, Systems Corp. of America.

Jim Broadston of Rocketdyne, Section President, was chairman of the meeting, and Dan Brewer, Ramo Wooldridge Corp., introduced the speakers.

Dr. Krieger began the discussion by outlining Russian developments in rockets and astronautics from the beginning of the 20th Century. He pointed out that German scientists only helped native Russian talent, which itself included an impressive group of academicians interested in space flight. He also referred to the many technical papers on rockets and astronautics which had appeared in Russian publications but which had, in the main, been ignored by western scientists.

Dr. Krieger also quoted reports from technical publications which described apparatus for tracking both Soviet and American satellites and which alerted readers for the launching of the Sputniks. He said that it was clear from Soviet technical journals in the summer of 1957 that Soviet satellite launchings were imminent.

Dr. Pickering stated that transmission frequencies of 20 and 40 mc had been chosen by the Russians because they were primarily interested in ionospheric data. Low frequencies are needed for accumulating this data and, indeed, American observations of the satellites had indicated unexpected ionospheric peculiarities. The tremendous amount of data obtained by recording the signals from the Sputniks needs reduction before more information can be given.

On the other hand, part of the American program is designed to obtain geodetic data, and this requires very accurate orbit determination. Accordingly, a high frequency (108 mc) which is unaffected by the ionosphere, was chosen.

The Soviets have stated that both Sputniks are part of their contribution to the IGY. As a result, data will be forwarded to IGY authorities. So far, this has not happened, and it is likely that the Russians will follow their usual procedure of not releasing any information until the data have been reduced and analyzed.

In the U. S., the orbits of both Sputniks were determined with a fair degree of accuracy. At the beginning, Sputnik I had an apogee of 600 mi and a perigee of 140 miles; Sputnik II, 950 miles and 150 miles, respectively. From the changes in the orbits, drag data in the exosphere have been obtained.

Dr. Barnes attempted to use current developments to suggest a possible time scale of astronautics. First, he stressed some differences between space flight vehicles and aircraft. With aircraft, a 1-lb increase in payload generally leads to a ninefold increase in over-all weight. In the case of a lunar space ship, the ratio becomes at least 600 to one and possibly even 1500 to one. Progress in propulsion systems was thus the governing factor in development of a space flight program, and Dr. Barnes based his estimates on expected developments in this field.

Offered Space Flight Schedule

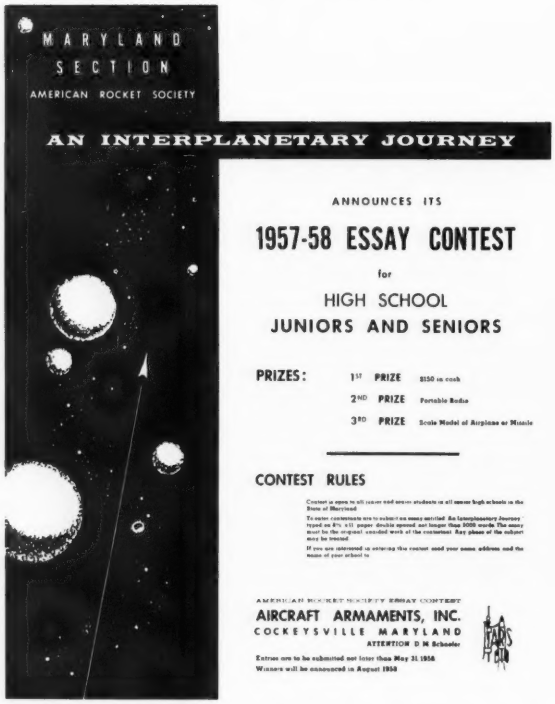
Typical accomplishments, he noted, might be to land instruments on the moon by 1959, and on Venus and Mars by 1964. A manned earth satellite is feasible by 1966, and a year after that circumnavigation of the moon should be possible. Landing by a manned ship on the moon might take place by 1971, with the nearer planets reached in 1975.

The audience showed considerable interest, and welcomed the opportunity to question the speakers.

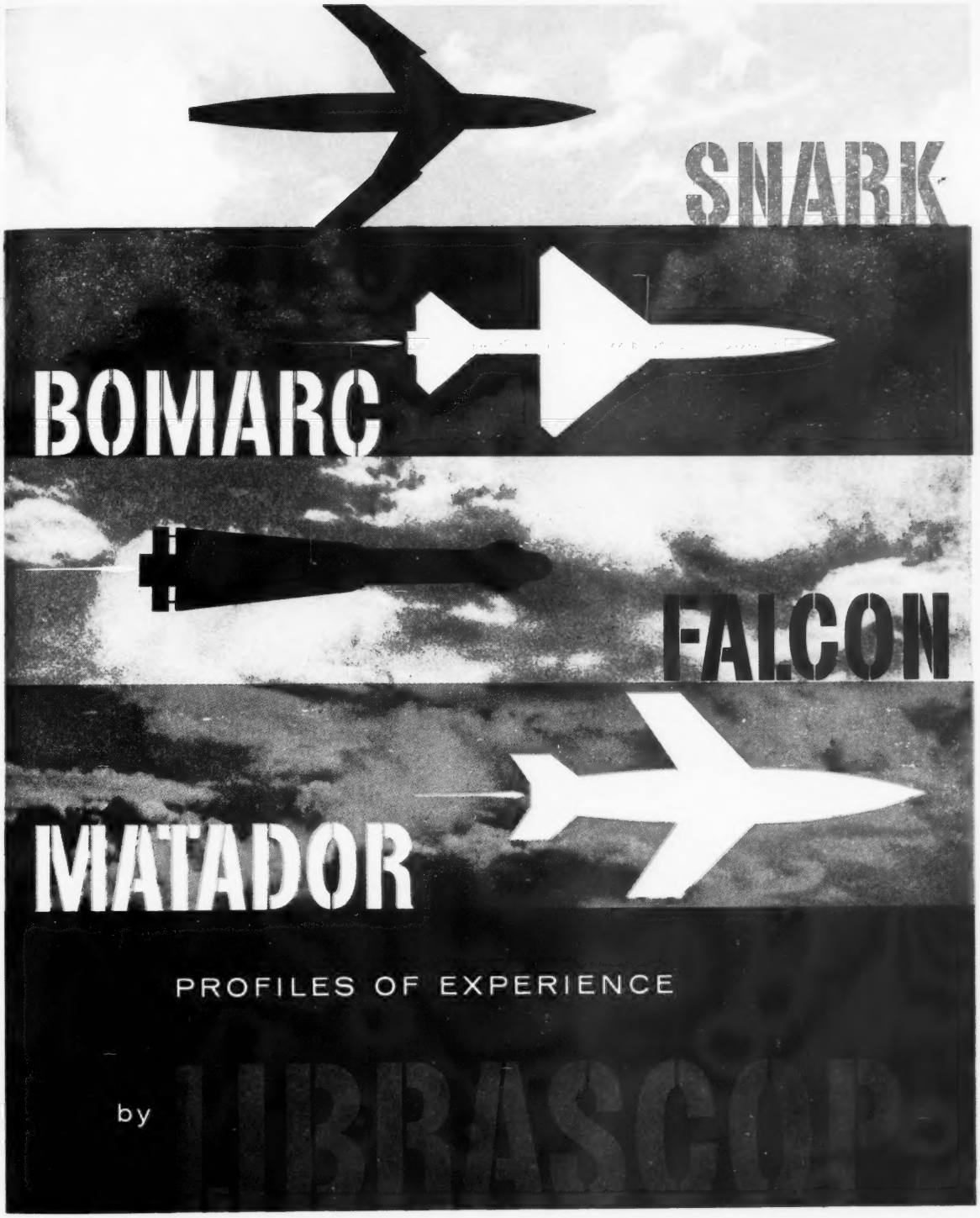
Asked how long military aspects would continue to dominate the space flight program and if a base on the moon would be in a position to control the earth, Dr. Barnes pointed out that any space flight program needs a great amount of money, and that military projects must dominate the program at first. He noted, however, that military projects often lead to civil benefits.

As for the base on the moon, Dr. Barnes regarded it as unlikely that it could play a dominant role. Means of mass destruction were already available on earth with long-range bombers, and soon with ICBM's, so a lunar base would not be of any significance in

Maryland Section Essay Contest Poster



This poster is being used to publicize the 1957–58 Essay Contest for high school juniors and seniors sponsored by the Maryland Section. Theme of this year's contest is "An Interplanetary Journey."



The demands of computer and control projects and problems over a 20-year period have earned for Librascope an enviable record of experience which is demonstrated by versatility and reliability in the design, development and manufacture of successful equipment. New demands of missile projects are reflected in Librascope's *profiles of experience.* This knowledge can be focused on *your* computer-control problems with the assurance of success. Librascope invites your inqury in this field. A letterhead request will bring you the Librascope story.

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changing the balance of military forces.

In reply to a comment that a manned trip to the moon was marginal with expected developments of chemical propellants, Dr. Barnes stated that such a voyage would probably have to be made by using orbital refueling.

Dr. Pickering was asked if there was a limit to the number of experiments which might be made with instrumented satellites. He stated that more experiments were already lined up than could be accommodated in satellite launchings planned so far.

Asked why the U. S. had picked an orbit having such a small inclination to the terrestrial equator, Dr. Pickering explained that range limitations were responsible. To place a satellite in an orbit of greater inclination would have meant tilting the launching angle to the South or North. In either case, there existed the possibility that the earlier stages would fall into inhabited areas or shipping lanes, and this could not be allowed.

In reply to a question as to whether retro-rockets had been tried for re-entry, it was noted that rockets had been used to accelerate re-entry in the final stages of test vehicles and could undoubtedly be used to slow down incoming vehicles. This was not practical with a nose cone, however, because it made it more vulnerable to countermeasures.

The inevitable question on UFO's was perfectly disposed of by the Chairman, who said that it was unlikely that any race, no matter how advanced, could insure against failures. No failures of alleged UFO's have been reported, he noted.

Eric Burgess

CORPORATE MEMBERS

The Research and Development Div. of Allen B. Du Mont Laboratories, Inc., has been organized into eight specialized laboratories under centralized control and direction. The Division is now broken down into Development, Systems, Communications and Radar, Data and Display, Military Television, Nuclear Instrumentation, Mechanical and Commercial Receiver laboratories.

The Martin Co.'s new $18 million missile plant in Orlando, Fla., is now in full operation. Major programs at the production facility are the Missile Master fire control system and the Lacrosse and Bullpup missiles. Designated Martin-Orlando, the facility is located in southwest Orange County, about 60 miles from Cape Canaveral. The plant has 500,000 sq ft of operating space and employs 2400 people.

The first Missile Master system has already been installed in the Washington-Baltimore area. The next system to come off the Martin-Orlando production line will be set up in the New York City area, according to a recent Army announcement.

STUDENT CHAPTERS

Parks College: New officers of the Parks College Chapter are James Morrison, president; George Woods, vice-president; Larry McConnell, secretary; and Kevin O'Donnell, treasurer. Martin Lanfranco is in charge of technical activities.

Wayne University: Students and faculty of Wayne University met in November to form a new ARS Student Section. Some 71 students turned out for the meeting. Ed Nielsen was on hand to give a short history of the ARS, while Joe Rutkowski provided faculty assistance. W. Glunk was student director for the meeting, while H. G. Donnely of the chemical engineering department aided in setting up constitutional and nominating committees.

The University is planning to give a course in rockets in the near future.

Brooklyn Poly: Due to the pressure of academic studies, two officers of the Chapter were recently forced to resign their posts. New officers, elected at the first meeting of the group this semester, are: Fred Schuyler, president; Arthur Martinez, vice-president; John Boccio, secretary; and Steven Starley, treasurer.

At Holloman Section's Annual Banquet

Above, some of the more than 300 members and guests who turned out to hear Andrew G. Haley and Welf Heinrich, Prince of Hanover, discuss space law at the annual banquet of the Holloman Section. Below, Haley, whose birthday coincided with the banquet, holds his birthday cake as (l to r) Knox Millsaps, newly elected President of the Section, the Prince and outgoing President Gerhard Eber look on.

Kaplan to Speak at L. A. Engineers Week Banquet

Joseph Kaplan, professor of physics at UCLA and chairman of the U. S. Committee for the International Geophysical Year, will be the featured speaker at a banquet to be held Wednesday evening, Feb. 19, at the Biltmore Bowl in Los Angeles as part of the national Engineers Week celebration Feb. 16–22.

The banquet is sponsored by the Los Angeles Council of Engineering Societies and the Los Angeles Technical Societies Council, which ARS Southern California Section belongs to.

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Dr. Kaplan's topic will be "A Small Planet Looks at Itself," and his talk will center on earth satellites, space travel, geophysical exploration and related subjects.

Several of the participating societies are planning special luncheons during the week, designed to honor and publicize the accomplishments of engineers.

Future ARS Headquarters?

This $10 million United Engineering Center in New York City may house the National Offices of ARS in the future. Expected to be ready for occupancy in the Fall of 1960, the building will serve as national headquarters for 16 engineering societies.

Tax Deductions Allowed For Society Activities

Unreimbursed expenses incurred in connection with professional society or association activities are deductible for tax purposes, according to a recent bulletin from the Engineers Joint Council.

The council notes that the Internal Revenue Service, under Ruling 55-4, I.R.B. 1955-1, states that a taxpayer who gives services gratuitously to an association, contributions to which are deductible under the relevant provisions of the Code, "and who incurs unreimbursed traveling expenses, including the cost of meals and lodging, while away from home in connection with the affairs of the association and at its direction, may deduct the amount of such unreimbursed expenses in computing his net income."

Such deductions, however, are subject to the limitation in respect to all gifts made to exempt organizations of this type—namely, that the total amount of such expenses in any one year may not exceed 20 per cent of the donor's gross income for such year. This limitation means that, while such expenses are deductible, they are included with other gifts in computing the 20 per cent limitation.

Pc Control System

(CONTINUED FROM PAGE 36)

over-all reliability of the vehicle. If the range is only wide enough to correct random errors, system failure will not result in complete failure, but only in a degradation of the over-all mission.

The system described here was primarily designed for a tactical vehicle. Control systems used for R&D studies on engines usually have a large dynamic range. This type of system would be overdesigned for a Pc Control system of the type required on a tactical vehicle. In this case, no transients are anticipated except on engine start. During the start phase this control system will exhibit an overshoot of approximately $3^1/_2$ per cent. There are no detrimental effects on the system because of this overshoot. By eliminating the requirement for control during the engine start, response of the system would be reduced. This is possible, since after the engine starts, the control system is only required to trim out slow, random variations in Pc.

For the past year and a half, flight test data on this system have been compiled. Numerous flights have shown that the system will maintain chamber pressure at better than $\pm$ 0.5 per cent of the desired Pc level. This is about twice as good as was called for in the original requirement. This demonstrates that a system can be designed which will allow interchangeability of individual components while still meeting rigid specifications. The main advantages of this system when added to an engine are reduction of the number of acceptance runs on engines, interchangeability of engine components, and simplification of the guidance computer on the over-all weapon system.

Future possibilities for the system can readily be seen if two or more engines are used. A matching control system could be utilized using the same components, as shown in the drawing on page 35. The pressure transducer is now placed between the two combustion chambers. Now, however, instead of maintaining a specified chamber pressure, the servo system maintains the ΔP at zero. However, if the relationship between Pc and thrust on each engine is not the same, the system balances the Pc difference required against an offset voltage equal to the difference in thrust level. This voltage is obtained from a reference signal generator and compared with the output of the pressure transducer.

The operation of the system from this point is the same as before. As may be seen in the diagram, the amplifier and motor drive are the same, as is the reference signal generator. The only changes would be in the control range of the valve, and in substituting a differential transducer for the pressure type.

If a Pc control system can be added to an engine without requiring a multitude of adjustments, the usefulness of the system will obviously be increased. Ease of maintenance and checkout procedures will increase the reliability of the control system, and, therefore, over-all reliability of the vehicle. Use of the building block technique allows for ease of maintenance and reduces the need for adjustments to a minimum. This technique also permits expansion of the system without extensive R&D work. By utilizing basic subsystems over and over again, reliability of components is increased, spare parts stocks reduced to a minimum and personnel training time cut.

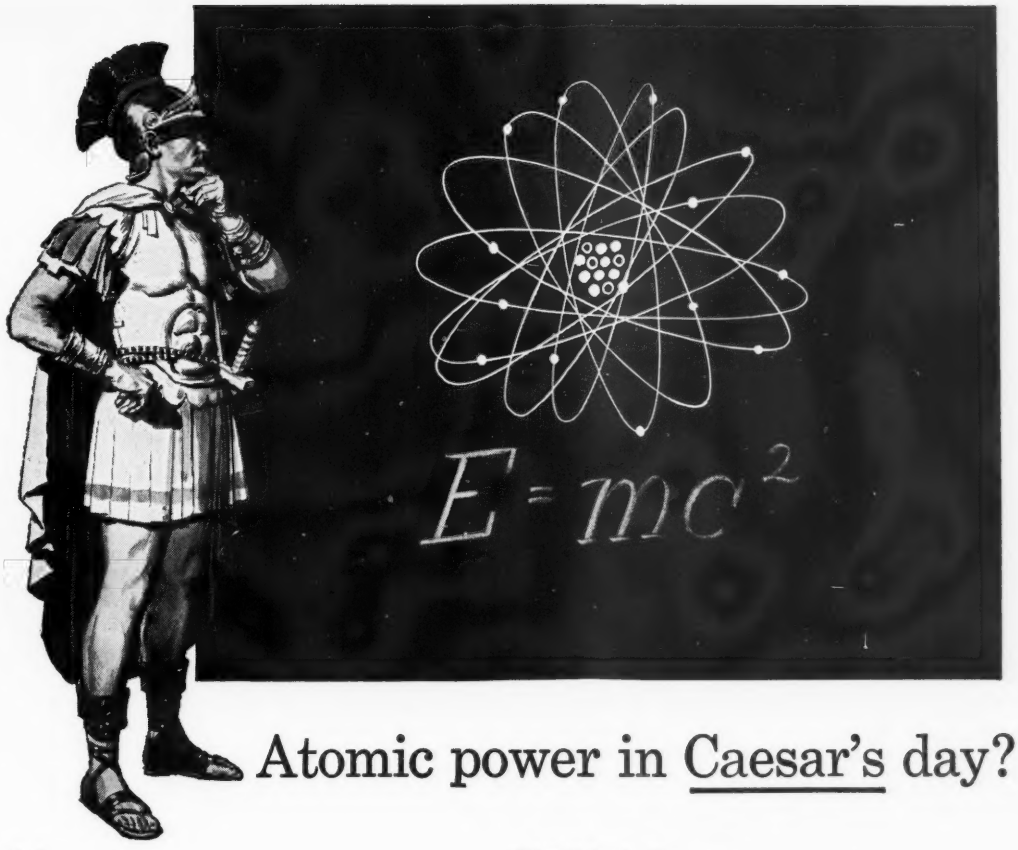
Aussies Play the Game, Too

Australia's claim to missile fame so far has rested almost entirely on its weapons proving ground at Woomera. However, this is now changing. A recent report from Australia discloses that an Australian-designed rocket underwent a successful test firing, reaching a speed of 3400 mph and an altitude of 80 miles. The rocket was a 30-ft long, two-stage affair, with the first stage consisting of three boost motors.

This rocket, says Australia, is not to be confused with the British high-altitude Skylark, which, confusingly enough, on its fourth successful shoot from Woomera reached a speed of 3307 mph and an altitude of 83 miles.

As far as Britain is concerned however, Woomera is still Australia's principle—if now not only—claim to missile eminence. Hampered by a heavy population, Britain has little room for running flight tests and so, out of necessity, has turned to the wilds of Australia to do its rocket shooting.

Latest report from the land "down under" is that England is preparing to sink an additional $14 million in the Australian weapons range to get it ready for the 2000-mile IRBM now being developed by de Havilland Propellers, Ltd.



Atomic power in Caesar's day?

Certainly!

It was there, in the ground, in the air and water. It always had been. There are no more "raw materials" today than there were when Rome ruled the world.

The only thing new is knowledge . . . knowledge of how to get at and rearrange raw materials. Every invention of modern times was "available" to Rameses, Caesar, Charlemagne.

In this sense, then, we have available *today* in existing raw materials the inventions that can make our lives longer, happier, and inconceivably easier. We need only *knowledge* to bring them into reality.

Could there possibly be a better argument for the strengthening of our *sources* of knowledge—our colleges and universities? Can we possibly deny that the welfare, progress—indeed the very *fate*—of our nation depends on the quality of knowledge generated and transmitted by these institutions of higher learning?

It is almost unbelievable that a society such as ours, which has profited so vastly from an accelerated accumulation of knowledge, should allow anything to threaten the wellsprings of our learning.

Yet this is the case

The crisis that confronts our colleges today threatens to weaken seriously their ability to produce the kind of graduates who can assimilate and carry forward our rich heritage of learning.

The crisis is composed of several elements: a salary scale that is driving away from teaching the kind of mind *most qualified* to teach; overcrowded classrooms; and a mounting pressure for enrollment that will *double* by 1967.

In a very real sense our personal and national progress depends on our colleges. They *must* have our aid.

Help the colleges or universities of your choice. Help them plan for stronger faculties and expansion. The returns will be greater than you think.

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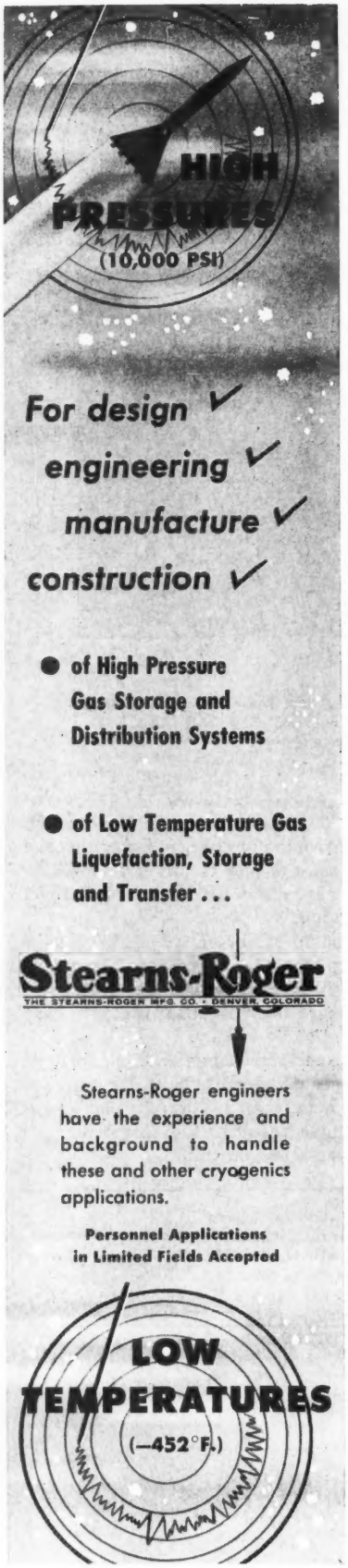
AMERICAN ROCKET SOCIETY, INC.



Everybody Has an Opinion on Satellites

Shortly after the first Soviet sputnik was sent into orbit, George Gallup and his American Institute of Public Opinion went into action to discover what the "man in the street-strasse-rue-straat" thought about this whole business. Here are some considered (and unconsidered) opinions:

"Do you feel that the Russian satellite is a serious blow to U. S. prestige?"

Asked in 11 world centers shortly after the advent of the first sputnik, this question was answered in the affirmative by a majority of people in New Delhi, Toronto, Paris, Oslo, Helsinki, Copenhagen and Vienna. On the other hand, in Washington, Chicago, Amsterdam, Stockholm and Brussels, the majority of citizens did not consider it a serious blow to U. S. prestige.

"Were you surprised that the Russians were able to do this before the U. S.?"

The majority of those queried in Toronto, Stockholm and Amsterdam were not. But in the other eight sampling spots, more people were surprised than were not.

"The U. S. was first to develop the atomic bomb. Russia was first with the satellite. Which country do you think will make the next great advancement of this nature—the U. S. or Russia?"

The answer to this question was interesting. Only in Oslo and New Delhi did the majority of those questioned believe it would be Russia. The Parisians left the matter open; 56 per cent said they didn't know.

Conducted U. S. Survey

Turning their attention completely to John Q. Public, the pollsters conducted a series of coast-to-coast surveys in the U. S., probing ever deeper into the thoughts of the American taxpayer on the subject of missiles and satellites.

"Do you think Russia is moving ahead of the U. S. in the development of missiles and long distance rockets?"

One out of every two adults interviewed (actually 49 per cent), believed that sputnik signified Russia had pulled ahead of the U. S.; 32 per cent said no; 19 per cent didn't know.

"How long do you think it will be before men in rockets reach the moon?"

Of those questioned, 34 per cent didn't know, 14 per cent thought the whole idea was silly and never would happen. For the rest, the median average of all estimates was 20 years.

"Are you satisfied with the present defense policies of the U. S., or do you think there is a need to take a new look at our defense policies?"

Only 26 per cent were satisfied, while 53 per cent thought a new look was needed; 21 per cent had no opinion.

"Why do you think Russia was able to launch an earth satellite before the U. S. did?"

Ranked in order of frequency of mention, the four principal answers were as follows:

The Russians worked harder and longer at it, concentrated on it.

Russia has better scientists; got scientists from Germany after World War II.

U. S. program was badly organized; interservice rivalry slowed our program down.

Russians made more money available for their satellite program.

The $64-billion question—Who is going to pay for a stepped-up space and military program?—went unasked and unanswered.

Miniature Rockets Used In Propulsion Tests

Miniature rocket motors are used in scale studies of the propulsion characteristics of Atlas, the Air Force ICBM now in pilot production by Convair-Astronautics at San Diego. The test rockets, with nozzles of 1 in. diam and developing 200-lb thrust, enable engineers in the Convair Thermodynamics Laboratory to study the behavior of rocket exhaust jets under varying conditions of altitude and velocity.

The laboratory duplicates altitude conditions up to about 40 miles in a cylindrical, steel vacuum tank, 6 ft in diam and 10 ft long. A miniature test rocket, fueled by gaseous oxygen and gasoline, is extended into one end of the tank and fired for as long as 1.5 sec. Through a one inch plate glass window, engineers watch how the rocket flame fans out as atmospheric pressure is reduced, permitting checks on how the expanding exhaust might impinge on nearby or surrounding surfaces.

New Human Factors Group

A new human factors group has been formed at the Airborne System Laboratory of the Radio Corp. of America at Waltham, Mass. Members of the staff, among others, are experimental psychologists W. R. Bush and Alex Weisz.

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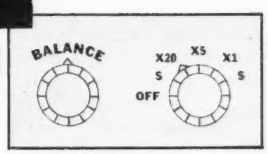
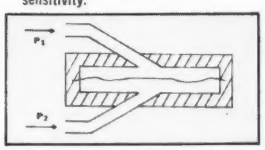
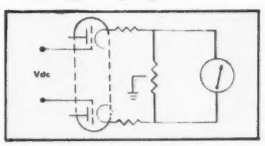


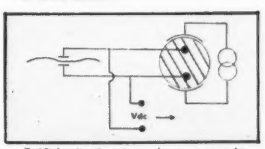
Two-knob control for balance, . . . sensitivity.



Pressure differential moves beryllium-copper diaphragm.



Output applied to cathode follower to drive meter.



T-42 Ionization transducer converts motion into electrical signal.

Utilizes the T-42 IONIZATION TRANSDUCER

This unusually simple pressure instrument is completely self contained. It requires no special accessories, additional equipment or trained personnel for operation. Merely plug this compact instrument (only 5" x 5" x 10") into the 115 V, 60 cy. line and in 2 minutes it is ready for use. Two knob control . . . for balance and sensitivity.

It is an extremely versatile and truly valuable accessory for any laboratory.

Details on this new micro-sensitive meter are in Instrument Data Sheet 303-1, available upon request to Technical Literature Section.

The *DECKER CORPORATION*

Bala Cynwyd, Pennsylvania

government contract awards

Republic to Build Drones

Republic Aviation has been awarded two contracts totaling $4.7 million for Army drone aircraft. The first contract calls for propeller-driven, all-weather drones for immediate operational use; the second, for an advanced jet type. Both are for operation by Army units in the battle area for surveillance, using photography or radar or infrared techniques. Both drones will be zero-length launched and recoverable.

Jet Contract to Grumman

An additional $40 million production contract for F9F-8T Cougar jet fighter trainers has been awarded to Grumman Aircraft by the Navy. The Cougar, a two-place transonic jet, has been used in qualifying pilots for carrier operations and supersonic flight.

Combat Surveillance Contract

Cornell Aeronautical Laboratory will undertake a two-year program to advance Army techniques of combat surveillance of the battlefield. Combat surveillance is a continuous and systemic watch over a combat area under all conditions of weather, both day and night. One task of the study will be to provide a way whereby commanders of the future will be able almost instantly to scan a large battle area, locate and identify a potential target, prepare missile guidance information, launch a missile and then verify results of a target strike.

$20 Million Contract Switch

The Air Force has agreed to the transfer of a $20-million contract from Rand Corp. to Systems Development Corp. The contract is with the Air Defense Command and involves installation and maintenance of a system training program for air defense and programming for computers in the SAGE air defense system.

Rand President F. R. Collbohm will serve as chairman of the board of trustees of SDC which, like Rand, is a nonprofit organization. The decision to form the new corporation, according to Collbohm, was reached when it became apparent that these fast-growing activities were getting farther and farther away from Rand's primary function as a scientific advisory organization engaged in long-range research, principally for the Air Force.

AEC Renews Pratt & Whitney Nuclear Propulsion Contract

The Atomic Energy Commission has renewed its contract calling for development of aircraft nuclear propulsion systems with Pratt & Whitney Aircraft Div. of United Aircraft. The cost-plus-fixed fee contract, originally begun in 1953, was extended to Sept. 30, 1960. It involves an estimated $15 million annually.

AF Contract for WS-110A Awarded to North American

The Air Force has awarded North American Aviation, Inc., a contract for development of the WS-110A chemical bomber designed as an eventual replacement for the Boeing B-52. Both North American and Boeing were competing for the contract for the Mach 3 intercontinental aircraft. The engine for the WS-110A is now under development by General Electric Co.

No dollar value was announced for the contract. The AF budget for fiscal 1958 includes an allocation of about $90 million for work on the aircraft and engine.

SYNOPSIS OF AWARDS

The following synopsis of government contract awards lists formerly advertised and negotiated unclassified contracts in excess of $25,000 for each Air Force, Army and Navy contracting office:

AIR FORCE

Commander, Hq AMC, Wright-Patterson AFB, Ohio.

Safety of flight and periodic inspections on F-100C type aircraft and installation of stainless steel leading edges on vertical stabilizers, $35,670, **North American Aviation, Inc.,** International Airport, Los Angeles, Calif.

Operation and maintenance of SAGE powerhouse equipment, including custodial services for the direction center, $498,606, **RCA Service Co., Inc.,** Camden 8, N. J.

J44-R-3 turbojet engines for C123 aircraft and related equipment, $755,981, **Fairchild Engine Div.,** Fairchild Engine & Airplane Corp., Deer Park, L. I., N. Y.

Airframe development program of T-38 jet trainer, $3,150,000, **Northrop Aircraft, Inc.,** Hawthorne, Calif.

Product improvement for Q-2 drone system, $165,000, **Ryan Aeronautical Co.,** San Diego, Calif.

Hq AF Cambridge Research Center, ARDC, Bedford, Mass.

Rocket, Aerobee-Hi sounding model; rocket booster, assembly, nose extension, $293,211, **Aerojet-General Corp.,** 6352 N. Irwindale Ave., Azusa, Calif.

Hq AF Flight Test Center, ARDC, USAF, Edwards AFB, Calif.

Time and materials for electrical maintenance of rocket base for one year, $90,250, **Sheldon Electric Co.,** 55 Hubbard St., San Fernando, Calif.

Hq AF Office of Scientific Research, ARDC, Washington 25, D. C.

Research studies on positive ion surface emission for ion propulsion systems, $146,450, **Aerojet General Corp.,** Azusa, Calif.

Research observation of burning propellants in rocket engines, $93,216, **Bell Aircraft Corp.,** Buffalo 5, N. Y.

Continuation of research on solid propellant combustion, $41,168, **Atlantic Research Corp.,** Alexandria, Va.

Continuation of research on solid state diffusion in semiconductor materials, $28,000, **Pacific Semiconductors, Inc.,** Culver City, Calif.

Continuation of research of plastic deformation of metals by the observation of single dislocations, $25,537, **The Franklin Institute,** Phila. 3, Pa.

Continuation of research of rational scaling procedures for liquid-fuel rocket engines, $82,227, **American Machine & Foundry Co.,** 10445 Glenoaks Blvd., Pacoima, Calif.

Research on analytical and experimental study of the effect of aerodynamic heating on aircraft structure, $102,500, **The Leland Stanford Jr. University,** Stanford, Calif.

Research on aerodynamic and heat transfer studies with evaporative cooling at hypersonic mach numbers, $66,500, **University of Minnesota,** Minneapolis 14, Minn.

Research and reports concerning supersonic combustion, $78,325, **Fairchild Engine Div.,** Fairchild Engine & Airplane Corp., Deer Park, L. I., N. Y.

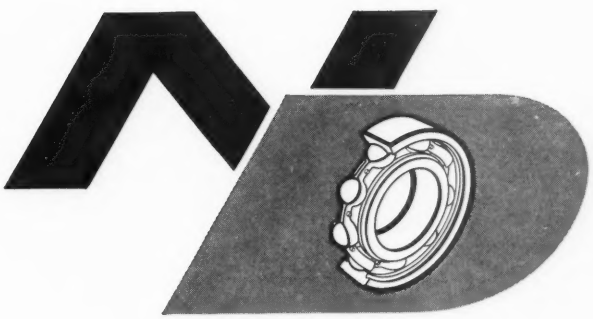
Continuation of research on high intensity plasma jet work to the 10000-kw power range, $78,850, **Giannini Research Corp.,** Santa Ana, Calif.

Research on hypersonic shock tube, $69,992, **Cornell Aeronautical Labora-**

NEW DEPARTURE

NEW DEPARTURE

NEW DEPARTURE



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tory, Inc., 4445 Genesee Street, Buffalo 21, N. Y.

Continuation of research on ultra-energy fuels for rocket propulsion, $193,-885, **Aerojet-General Corp.,** Azusa, Calif.

Continuation of research on flame stabilization of bluff bodies at high speed and large Reynolds Numbers, $53,317, **University of Minnesota,** Minneapolis, Minn.

Research on study of aerodynamic noise, $49,372, **Gruen Applied Science Laboratories, Inc.,** Hempstead, N. Y.

Hq AF Test Center, ARDC, USAF, Edwards AFB, Calif.

To provide support services for weapons system 107A and 315A, $70,716, **C. A. Sheldon Electric Co.,** 55 Hubbard St., San Fernando, Calif.

Hq Middletown Air Materiel Area, USAF, Olmsted AFB, Pa.

Liquid oxygen, $64,000, **California Oxygen Co. of Los Angeles,** 511 S. Fullerton Rd., La Habra, Calif.

Hq Sacramento Air Materiel Area, McClellan AFB, McClellan, Calif.

Complete rehabilitation of F-86F type aircraft, $500,000, **North American Aviation, Inc.,** Los Angeles International Airport, Los Angeles 45, Calif.

Rehabilitation and modification of F-86D type aircraft, $1,000,000, **North American Aviation, Inc.,** Los Angeles International Airport, Los Angeles 45, Calif.

Hq San Antonio Air Materiel Area, USAF, Kelly AFB, Tex.

Iran (Inspection and Repair as Necessary) and modification of F-102 type aircraft, $1,400,000, **General Dynamics Corp.,** Convair Div., Fort Worth, Tex.

Control cabin temperature required to support F89D&H aircraft, $65,982, **Standard Thomson Corp.,** Clifford Mfg. Co. Div., 152 Grove Street, Waltham 54, Mass.

Modification of F-102 type aircraft, $2,531,240, **General Dynamics Corp.,** San Diego, Calif.

Warner Robins Air Materiel Area, USAF, Robins AFB, Ga.

Spare parts applicable to F100D aircraft, $129,448, **North American Aviation, Inc.,** Los Angeles 45, Calif.

ARMY

Corps of Engineers, U. S. Army, Office of the District Engineer, Jacksonville Dist., 575 Riverside Ave., Jacksonville, Fla.

Construction of GE guidance facilities, AF Missile Test Center, Patrick AFB, Fla., $561,141, **Paul Smith Construction Co.,** P. O. Box 2866, Orlando, Fla.

Construction of additions and modifications to complex 17 and 18, AF Missile Test Center, Patrick AFB, Fla., $274,570, **Paul Smith Construction Co.,** P. O. Box 2866, Orlando, Fla.

Los Angeles Ordnance Dist., U. S. Army, 55 So. Grand Ave., Pasadena, Calif.

Propellant development, $53,943, **Grand Central Rocket Corp.,** P. O. Box 111, Redlands, Calif.

Military Petroleum Supply Agency, Washington 25, D. C.

Jet fuel 3, 1,000,000 gal, **Socony Mobil Oil Co., Inc.,** New York, N. Y.

Rocket fuel, $539,648, **Tidewater Oil Co.,** 79 New Montgomery St., San Francisco, Calif.

New York Ordnance District, 180 Varick St., New York 14, N. Y.

Research and development of the Nike-Zeus (Nike II) guided missile system, $33,650,481, **Western Electric Co., Inc.,** 120 Broadway, New York 5, N. Y.

Study, design and fabrication of three prototype accelerometer monitors for ground equipment in the Jupiter guidance system, $49,891, **Bulova R&D Labs., Inc.,** 62-10 Woodside Ave., Woodside 77, N. Y.

Design, development, manufacture and test of airborne radio telemeter set, pulse duration modulation encoder to digital ground base, $38,166, **Consolidated Avionics Corp.,** 66 Brooklyn Ave., Westbury, N. Y.

Philadelphia Ordnance Dist., 128 N. Broad St., Phila., Pa.

Nike spare parts & components, $105,-506, **Western Electric Co.,** Burlington, N. C.

Feasibility study, simulating loop of servo system, $92,340, **The Franklin Institute,** Phila., Pa.

Research and development of canopy actuator remover T-19 for the F106B airplane, $82,101, **Aircraft Armaments, Inc.,** Cockeysville, Ind.

Nike spare parts & components, $112,-195, **Western Electric Co.,** Burlington, N. C.

Facilities for government account for use in Talos evaluation unit White Sands Proving Ground, $95,637, **Radio Corp. of America,** Moorestown, N. J.

Nike spare parts and components, $255,929, **Western Electric Co.,** Burlington, N. C.

Redstone Arsenal, Huntsville, Ala.

Continued research and development in the field of solid propellant rocketry; operation of pilot lines and facilities, $1,590,001, **Rohm and Haas Co.,** Philadelphia, Pa.

Propellant mixture, guided missile, M3, packaged in premetered containers, $183,-750, **National Cooler Div.,** W. F. Ryan Corp., 2404 Prospect, Cleveland, Ohio.

Development and delivery of modified XM10 rocket motors, $152,992, **Thiokol Chemical Corp.,** Trenton, N. J.

Design and development of solid propellant vernier engine, $196,398, **Thiokol Chemical Corp.,** Trenton, N. J.

13,000 manhours of engineering and design services, $75,000, **Consultants and Designers, Inc.,** 650 Eleventh Ave., New York, N. Y.

Load center, unit substation, with remote control push button panel for switchgear breakers, $27,631, **Continental Electric Equipment,** 205 West 4th St., Cincinnati 1, Ohio.

San Francisco Ordnance Dist., 1515 Clay St., P. O. Box 1829, Oakland 12, Calif.

Research program in development of army ordnance surface-to-air missile system, $650,000, **Stanford Research Institute,** Menlo Park, Calif.

U. S. Army Ordnance Dist., Los Angeles, 35 So. Grand Ave., Pasadena, Calif.

Furnishing and delivering of depot replenishment repair parts for Corporal missile system, $567,117, **Gilfillan Bros., Inc.,** 1815 Venice Blvd., Los Angeles 6, Calif.

Supplies and services relating to the Honest John missile, $63,234, repair parts for Nike system, $242,601, **Douglas Aircraft Co., Inc.,** 3000 Ocean Park Blvd., Santa Monica, Calif.

Corporal handling and launching equipment, $994,123, **Firestone Tire & Rubber Co.,** 2525 Firestone Blvd., Los Angeles, Calif.

NAVY

Department of the Navy, Bureau of Aeronautics, Washington 25, D. C.

Bomb rack and rocket launcher, $1,-207,500, **Ruffe, Inc.,** 7525 Northwest 37th Ave., Miami, Fla.

District Public Works Office, Officer in Charge of Construction, Fourth Naval Dist., U. S. Naval Base, Phila. 12, Pa.

Ram blower building extension and altitude test chamber expansion, Naval Air Turbine Test Station, Trenton, N. J., $5,140,000, **Nalan Construction Corp.** and **Dean Construction Co., Inc.,** 2 Park Ave., New York 16, N. Y.

Navy Dept., Officer in Charge of Construction, Potomac River, Naval Command, U. S. Naval Gun Factory, Washington 25, D. C.

Turbo-jet engine test facility at the Naval Air Station, Patuxent River, Md., $149,845, **Merando, Inc.,** 4098 Minnesota Ave., N. E., Washington, D. C.

Purchasing Office, Dept. of the Navy, Bureau of Aeronautics, Washington 25, D. C.

Chemical filter cartridges for use in naval aircraft liquid oxygen systems, $26,-140, **Mine Safety Appliances Co.,** 201 N. Braddock Ave., Pittsburgh 8, Pa.

Name Three Cruisers To Be Missile Ships

The three heavy cruisers scheduled to be converted to guided-missile cruisers in the fiscal 1958 program will be the Chicago, Albany, and Fall River, the Navy has announced. They will receive Talos and Tartar surface-to-air missile armament.

Cruiser conversions will consist of installing guided-missile launching capabilities both forward and aft. In previous conversions, such as the Boston and Canberra, conventional armament has been retained forward while missile launchers were installed aft.

The six light cruiser conversions now under way—five from the fiscal 1957 program and one from the fiscal 1956 program—will have missile launchers aft and conventional armament forward. Three will be armed with Terrier, three with Talos.

a step beyond push-button warfare!

TALOS

This Talos launching from the RCA Defense System on Dec. 13, 1957, resulted in direct hit on distant drone plane.

The RCA Talos Defense System is the first *completely automatic* land-based system for launching and guiding missiles, and utilizes the Talos Missile developed by the Applied Physics Laboratory and produced by Bendix. The Defense Unit receives target signals from remote outposts, analyzes them with regard to number of attackers, location, course and speed. Next, computers determine the logical points of interception, order the missiles loaded on launchers, guide them at supersonic speed to the vicinity of the target, after which the missiles "lock" on the target and close in for its destruction. All without even the touch of a button! The RCA Talos Defense System, with its electronic equipment and guidance systems, was designed, developed and built by RCA as prime contractor, aided by many subcontractors. It was turned over to the U. S. Army on October 15, 1957, and is a missile milestone, exemplifying the continuing determination of American enterprise to secure peace with honor and justice.

RCA Tmk(s) ®

RADIO CORPORATION of AMERICA

DEFENSE ELECTRONIC PRODUCTS

CAMDEN, N. J.

(CONTINUED FROM PAGE 25)

Basement Rocketeers

and public exhibits of work carried out by such groups.

The ARS Committee on Amateur Rocketry would assist youth and amateur rocket groups in securing instructors and textbooks on rocket fundamentals and design, and would help in setting up libraries containing books on such subjects at local schools and universities.

During courses of instruction, group and individual projects would be supervised by competent instructors. Upon completion, projects would be evaluated and, if evaluation indicated static firing as the next step, arrangements would be made to conduct supervised firings. After static firings, live firings might also be carried out through the cooperation of local military installations or private industry.

Preparing Book on Rocketry

Toward this end, Col. Parkin's committee is now preparing a book on amateur rocketry to be used by model rocket clubs. It begins with an introduction to rocketry and concludes with complete design specifications for three rockets—two solid propellant rockets and one liquid propellant type. It also includes a chapter by Col. Parkin himself on safety precautions to be taken in experiments.

The book, which, it is hoped, would be published and made available at minimum cost, possibly through ARS, is actually an outline for a 40-hr course in rocketry at the high school level. It consists of 10 chapters, each of which could be used for a basic 4-hr course in a particular aspect of rocketry.

ARS has already sent letters to the National Science Foundation, the President's Committee on Scientists and Engineers and the Defense Department, endorsing Col. Parkin's basic plan and recommending that action be taken on the program.

"Only a small sum is needed to carry out a program of this type," Col. Parkin noted. "If you'll recall, the German Luftwaffe developed out of amateur glider clubs, and there's no reason why youth rocket clubs in this country shouldn't be a potent factor in supplying engineers and scientists for rocket and guided missile programs of the future."

Col. Parkin is enthusiastic about the support his committee has received for the program. The Corps of Engineers is already on record as "supporting the general principle of stimulating interest in science," and local industry, as well as government installations, have been generous in making facilities available to youth rocket groups in the area.

Arthur Kantrowitz of Avco Mfg. Co. recently estimated that an engineer does not actually begin to produce until three or four years after receiving his degree. This means that youngsters now beginning high school will not make any significant contributions to the nation's rocket and guided missile program for 11 or 12 years.

By fostering the interest that many of the nation's youngsters are now showing in rockets, the ARS amateur rocketry program can go a long way toward assuring the fact that, 10 or 15 years from now, the U. S. will still be in the vanguard in this field.

The International Scene

By Andrew G. Haley

The keynote of the Ninth Annual Congress of the International Astronautical Federation, to convene in Amsterdam during the week of Aug. 25, 1958, is *worthwhileness.*

In the area of *worthwhileness*, the chief concern is with respect to the papers which will be presented. No IAF Congress is worthwhile unless the young scientist, the novice theoretical physicist, the engineer with vision, and all those who have the stars in their eyes, are afforded an opportunity to present papers. However, each paper must conform to standards of uniform excellence.

No paper will be presented at the Ninth Congress which has not been approved in writing by at least one member of the Astronautica Acta Committee of the IAF. This committee is composed of Friedrich Hecht, president, Oestrreichische Gesellschaft für Weltraum Forschung Alserstrasse 69/18, Vienna VIII, Austria, Chairman; Wolfgang B. Klemperer, Douglas Aircraft Co., 3000 Ocean Park Blvd., Santa Monica, Calif., Vice-Chairman; J. M. J. Kooy, president of our host Society, Nederlandse Vereniging voor Ruimtevaart, St. Ignatiusstraat 99a, Breda, The Netherlands; Eugen Sänger, Forschungsinstitut f. Physik d. Strahlantriebe, Stuttgart-Flughafen, West Germany; Leonid I. Sedov, Commission on Astronautics, Academy of Sciences, Moscow, U.S.S.R.; L. R. Shepherd, 28 Avon Road, Chilton, Berks, England; and J. A. Stemmer, Secretary of the IAF, P. O. Box 37, Baden, Switzerland.

° ° °

The functioning of the Astronautica Acta Committee in no way interferes with, or supersedes, the functioning of any program or other appropriate committee of IAF member societies. In other words, all papers from members of the AMERICAN ROCKET SOCIETY would be presented to the IAF after having been processed and approved by the ARS Program Committee. Such processing and approval, however, while essential for clearance through ARS, does not guarantee that the paper will be accepted by the Astronautica Acta Committee. For example, with respect to American papers, this approval need not necessarily come from the American member of the Committee—Dr. Klemperer. Approval may be given by any member of the Astronautica Acta Committee. The Committee is inviting scientists of world-wide renown, from all the areas of the world, to present original papers of abiding interest at the Congress. It is hoped that many of these papers will become classical landmarks in the natural and social sciences concerned with astronautics.

° ° °

This month we must pay a mass tribute—to the astronauts of Santa Barbara, Calif. After lecturing on schedule on our route from Princeton, through the Middle West and onto the West Coast, and including a West Coast lecture at UCLA, the Prince of Hanover and I were importuned to give our lecture also on the Santa Barbara campus of the University of California. One of the main attractions to both of us was the thought that, during the course of our lectures, the Central California Section of the AMERICAN ROCKET SOCIETY might be organized.

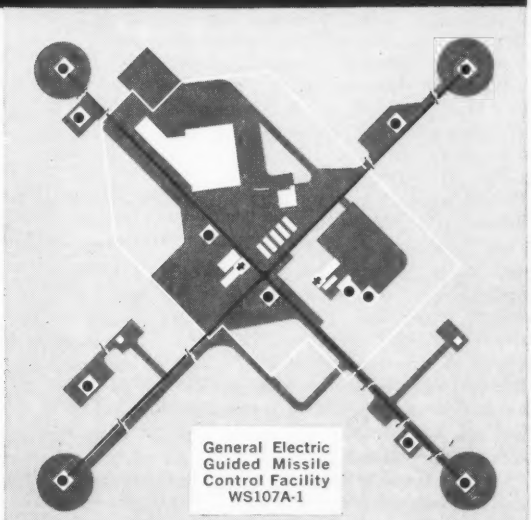
Jim Broadston, the indefatigable and altogether excellent President of the ARS Southern California Section, drove us to Santa Barbara and back to Los Angeles. He was truly self-sacrificing and he directed our activities with kindliness, patience and great intelligence.

The Prince of Hanover and I were pleased indeed to give our lecture at this first meeting of the proposed ARS Central California Section. The meeting was attended by 265 persons, the Washington School Auditorium being filled to capacity, and telephone calls and letters were received from 336 persons expressing their desire to become members of the new Section.

GRADUATE EE'S: GENERAL ELECTRIC DISCLOSES HIGH PRIORITY PROGRAM FOR ATLAS GUIDANCE SYSTEM. MANY POSITIONS OPEN IN ELECTRONIC MISSILE TECHNIQUES=

ACCURACIES ON ORDER OF 1 PART IN 10 MILLION

required for portions of G.E.'s ICBM ATLAS Guidance System



Delivering an ICBM over a > 5000 mile trajectory into the target area demands a guidance system of unprecedented accuracy—and this is the calibre of the electronic system General Electric engineers are creating for ATLAS.

But achieving designated accuracies and reliabilities in the laboratory is not enough. *These high standards must be maintained in actual operational environments, with virtually no interruption or degradation.*

CAREERS IN STEP WITH THE FUTURE

Engineers who join the Missile Guidance Product Section of G.E. are doing more than hastening development of one of the nation's most urgent programs – guidance for ATLAS. As Manager of the Section Richard L. Shetler states: *"With this job behind us, there will remain no significant obstacle to the practical guidance and navigation of other space vehicles."*

PROGRAM ACCELERATION OPENS UP POSITIONS AT ALL LEVELS IN:

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If you feel that your special skills and interests fit you to work in any of the above areas, why not write us in detail? Qualified candidates will be invited to visit our facilities to meet with technical managers and gain first hand knowledge of the living advantages of our locations at Syracuse and Utica, N. Y.

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MISSILE GUIDANCE PRODUCT SECTION

GENERAL ELECTRIC

Court Street, Syracuse, N.Y.

from the patent office

BY GEORGE F. McLAUGHLIN

Jets Used to Propel Helicopter Rotor

Helicopter lift is accomplished by means of a rotor with a vertical air compressor in the hub, and four rotor blades with ducts extending from the hub to the blade tips. A gas turbine inlet in each blade connects with the compressor outlet, and its outlet with a ducted opening at the blade tip. The exhaust from the blade tips of each turbine propels the rotors. The compressor rotor is in a drive relation with each turbine rotor, so that the shaft power taken to drive the compressor is one-quarter of the power absorbed by the compressor.

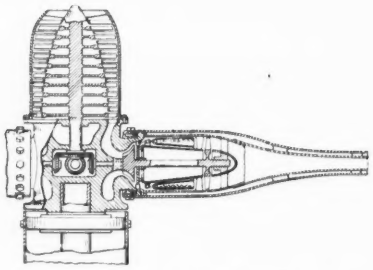
The turbine operates in a somewhat conventional manner. Air drawn into the compressor impeller is pressurized and delivered to the combustion apparatus where it is mixed with fuel and ignited to form hot gases. Only part of the energy of the gases is absorbed in the turbine wheel, the remainder flowing out through the blade and discharging through the exhaust nozzle.

The primary air compressor unit, of the multiple-stage, axial-flow type, with a bladed rotor structure, is mounted on the hub. The hub is supported upon the pylon by a shaft and received in a bearing in the pylon. The hub has a passageway from the compressor outlet to the compressor impeller inlet. The curved passageway has a number of outlet portions (one for each blade). Each outlet is normal to the inlet passageway and is spaced angularly from the others, so that the passageway divides at its outlet to provide each turbine with compressor air.

The inner wall of the hub has a central chamber isolated from the passageway. Within the chamber, a driving gear interconnects the turbine and the rotor of the primary compressor.

Blades are of the variable pitch type, rotatable about a longitudinal axis relative to the hub. Each blade has a series of rollers received in an annular recess in the hub. However, the turbine units are nonrotatably attached to the outer wall of the hub, so that they are not effected by rotation of the blades.

In operation, each turbine may be started by feeding fuel and ignition to create the motive gases. On rotation of the turbine wheel, the shaft drives the impeller and driving gear. The driving gear meshes with the driven gear, also driving the primary compressor rotor, and air is drawn through an inlet into the compressor. The air is pressurized in transit and delivered to the passageway, where it divides and flows to its associated turbine. From here, it is further pressurized before delivery to the combustion apparatus. Hot gases flowing through the turbine wheel blading are directed radially outward to the exhaust nozzle.



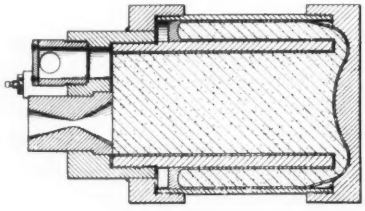
Sectional view, showing air compressor in the vertical shaft and gas turbines in rotor blade roots of a helicopter. Nozzles exhaust at blade tips.

Patent 2,814,349 (Aircraft Propulsion Apparatus). David W. Berry, Kansas City, Kans., assignor to Westinghouse Electric Corp.

Rocket Motor Designed For Return Burning

As the fuel in a rocket motor is consumed, the center of gravity shifts considerably. Also, a long burning time requires a motor of considerable length. A new invention overcomes these disadvantages through use of a folded combustion chamber with two or more concentric fuel cylinders.

Propellant burning begins in the inner chamber and moves progressively to the outer chamber or chambers. In this manner, changes in the center of gravity resulting from consumption of the propellant are reduced, and optimum fuel burning time is provided for a propellant container of a given length.



Cross section of return burning motor.

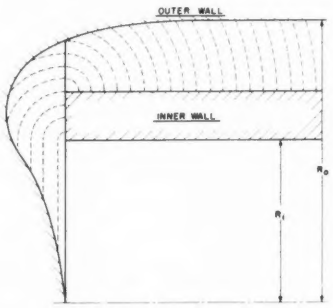
Forward and rear end plates on the motor are joined by an outer shell. The rear end plate, which is stepped, supports and covers the end of an inner cylinder, and has an opening for a nozzle. As a safety measure, the rear plate has an opening, normally closed by a plug, which clamps a blowout disk in place.

The inner cylinder, which terminates short of the forward plate, defines an inner chamber; the space between the two cylinders constitutes an outer chamber. The chambers communicate by the clearance between the forward end of the cylinder and the front plate. The front plate inner surface is contoured so that the effective area between the adjacent end of the inner cylinder and the front plate inner wall equals the inner combustion chamber area. Similarly, the annular combustion chamber has an effective area equal to that of the inner combustion chamber.

Both combustion chambers, as well as the space between the cylinder and the front plate, are filled with solid propellant. Combustion chamber surfaces and the confronting face of the front plate are covered with a protective lining.

The surface of the propellant adjacent to the nozzle is ignited by a spark plug or other ignition means. Upon ignition, the surface of the propellant burns forward within the combustion chamber, progresses around the forward end of the cylinder, and burns rearward in the outer chamber.

Patent 2,814,179 (Return Burning Motor). Leonard B. Edelman, Baton Rouge, La., and Clyde F. Miller, Sacramento, Calif., assignors to the U. S. Navy.

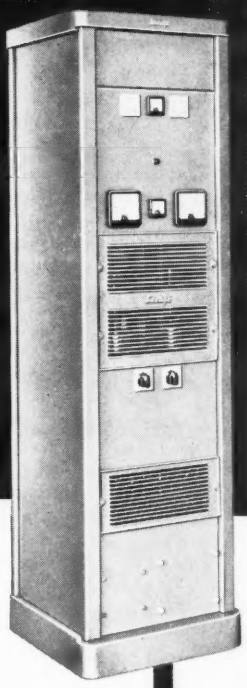


Burning faces of solid propellant at different stages are indicated by broken lines. R_o and R_i represent radii of outer and inner walls.

6 cps to 100,000 cps at

1,000 WATTS CONTINUOUS DUTY

...with the new Genisco-Savage high-output amplifiers!



Here's the new line of quality, high-output amplifiers you've been waiting for! All seven models feature high power output, low distortion, exceptionally high reliability and stability, and excellent output voltage waveform.

The Model KLF, shown at left, is particularly useful as an exciter for vibration testing equipment and as a variable frequency power supply for a multitude of production and laboratory needs. It will operate *continuously* with an output of 1,000 watts from 6 to 2,000 cps.

Components of all Genisco-Savage Amplifiers are mounted on 19" vertical panels to facilitate easy inspection and maintenance. Quick-release grill covers make all tubes readily accessible from the front. Numerous built-in safety features protect the equipment from operator errors.

Two New Shake Tables Available The new Model V1000 Genisco-Savage Shaker features a very light moving coil assembly, high thrust-to-weight ratio, automatic impedance matching, and an excellent output waveform. A continuous alternating thrust of ±600 lbs. is produced at 1,000 watts control power. Thrust can be increased to ±750 lbs. peak by use of a blower (Model V1000B). Both models have been stress-tested to withstand continuous operation at accelerations of 100 G's.

Seven models—rugged enough for production line testing; versatile enough for almost all laboratory needs.

The Genisco-Savage Model V1000 Shaker

BRIEF SPECIFICATIONS	MODELS						
	BM2	DM2	KM2	10K	KM2S	KLF	KRF
Output	250 w at 50 or 100 v	500 w at 50 or 100 v	1000 w at 50 or 100 v	10,000 w maximum	1000 w at 50 or 100 v	1000 w at 50, 100, or 200 v	1000 w at 25, 50 or 100 v
Frequency Range	50 to 10,000 cps at 250 w	50 to 10,000 cps at 500 w	50 to 10,000 cps at 1000 w	40 to 10,000 cps at 10,000 w	50 to 10,000 cps at 1000 w	6 to 2000 cps at 1000 w	5 to 100 kc at 1000 w
Sensitivity	0.036 v at 600 ohms	0.04 v at 600 ohms	0.1 v at 600 ohms	0.16 v rms at 600 ohms for 10,000 w output	0.1 v at 600 ohms	0.05 v at 600 ohms	0.5 v at 600 ohms
Distortion	1% at 250 w, 1000 cps	0.75% at 500 w, 1000 cps	Less than 0.75% at 1 kw, 1000 cps	Less than 3% at 10 kw, 1000 cps	Less than 0.75% at 1 kw, 1000 cps	Less than 5% at 1 kw, 10 to 1000 cps	

Price and delivery of both amplifiers and shakers are exceptionally good. For complete specifications and prices send for the new four-page illustrated brochure.

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Genisco, Incorporated
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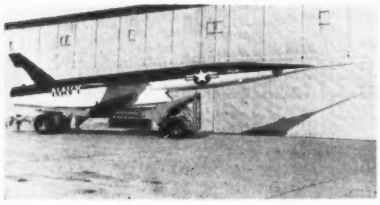
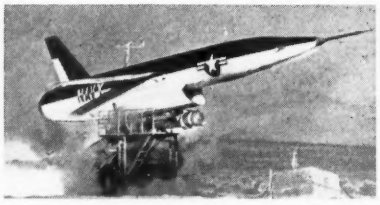
Los Angeles 64, California

Regulus II Reaches 1200 MPH in Desert Tryout





At left, Regulus II rolls from hangar on special launcher cart. Center, missile, to which rocket bottle has been fixed, leaves launcher. At right, missile in flight. After bottle boosts missile into air, it drops off and jet engine takes over.

The Regulus II surface-to-surface missile, designed by Chance Vought for the Navy, is rapidly moving out of the development phase, preparatory to going into operational status with the fleet some time in 1959.

The missile is reported to have a top speed above Mach 2 and a range in excess of 1000 miles. In a recent test, it reached a speed of 1200 mph and was successfully landed and recovered after a 30-min flight. In addition to a single, jettisonable rocket booster, the missile is powered by a J-79 jet engine with afterburner.

In test and training flights, Regulus II is guided by a command system from a ground unit or from a mother aircraft. In combat, where there is no interest in recovery, the missile will use an aided inertial system of guidance. The vehicle has nuclear capability and is designed for use by both surface ships and submarines.

Regulus II is 57 ft long and has a wingspan of 20 ft. Its altitude capability is above 60,000 ft. The recoverable version of the vehicle has a retractable tricycle landing gear and a parachute brake. The brake is released automatically when the missile hits the runway (at speeds of better than 250 mph).

At present, the Navy is putting Regulus II through a series of flight tests at Edwards Air Force Base.

Notorious Unreliability

(CONTINUED FROM PAGE 27)

out of three missiles would fail. A more complex missile, consisting of 400 components having the same 99 per cent component reliability, would have an over-all reliability of only 3 per cent. Thus, 97 out of 100 missiles would fail!

In the ordinary commercial field, an average component reliability of 99 per cent is considered quite satisfactory. However, as indicated by our diagram, this 99 per cent component reliability is catastrophically poor for guided missiles. We must strive for component reliability such that not more than one unit out of 10,000, or even 100,000, will fail. In other words, we must strive for "absolute" reliability of components.

The crucial relationship between complexity and over-all reliability is not entirely obvious. People keep asking: "Why are our piloted aircraft so reliable? Aren't they complex, too?"

Indeed, looking into the pilot's cabin of a four-engined airliner, we get the impression of enormous complexity. However, few of these thousands of components are really vital. They may fail, and they do fail, once in a while without any serious consequences because the pilot can do without them and bring the aircraft safely back home for inspection and repair.

In piloted aircraft, only a dozen or two components, mostly structural in nature, are really vital in that their failure would cause total loss and a catastrophe. These few vital components, of course, are designed and manufactured for an extremely high degree of reliability. That's why piloted aircraft are so reliable.

Not so with guided missiles. Here, each and every component, down to the last resistor, capacitor or even soldered joint, is vital, in that the failure of any one component will cause the missile to miss its target, thus becoming a complete loss. As a result, we must be happy if one out of two missiles hits the target.

Vital Complexity Important

Obviously, it is not complexity as such, but rather *vital* complexity, that must be considered in judging what degree of over-all reliability may be attainable. The vital complexity of guided missiles is perhaps 100 times higher than that of piloted aircraft. This explains why guided missiles are perhaps 100 times, or even 1000 times, less reliable than piloted aircraft.

Although by now it is widely appreciated that complexity is one of the main causes of unreliability, complexity is still rising rapidly, as shown in the graph on page 27.

The trend toward complexity is caused by the fact that rapidly increasing requirements can be met only by increasing automation, and that growth in component reliability is not proceeding at the same pace as growth in complexity.

Evidently a deficit exists between required and actual component reliability. This deficit is rapidly growing, year by year, and there seems to be no end to it. As a result, the over-all reliability of much of our new equipment may get stuck at reliability levels far below that which has been specified and hoped for—a disquieting fact.

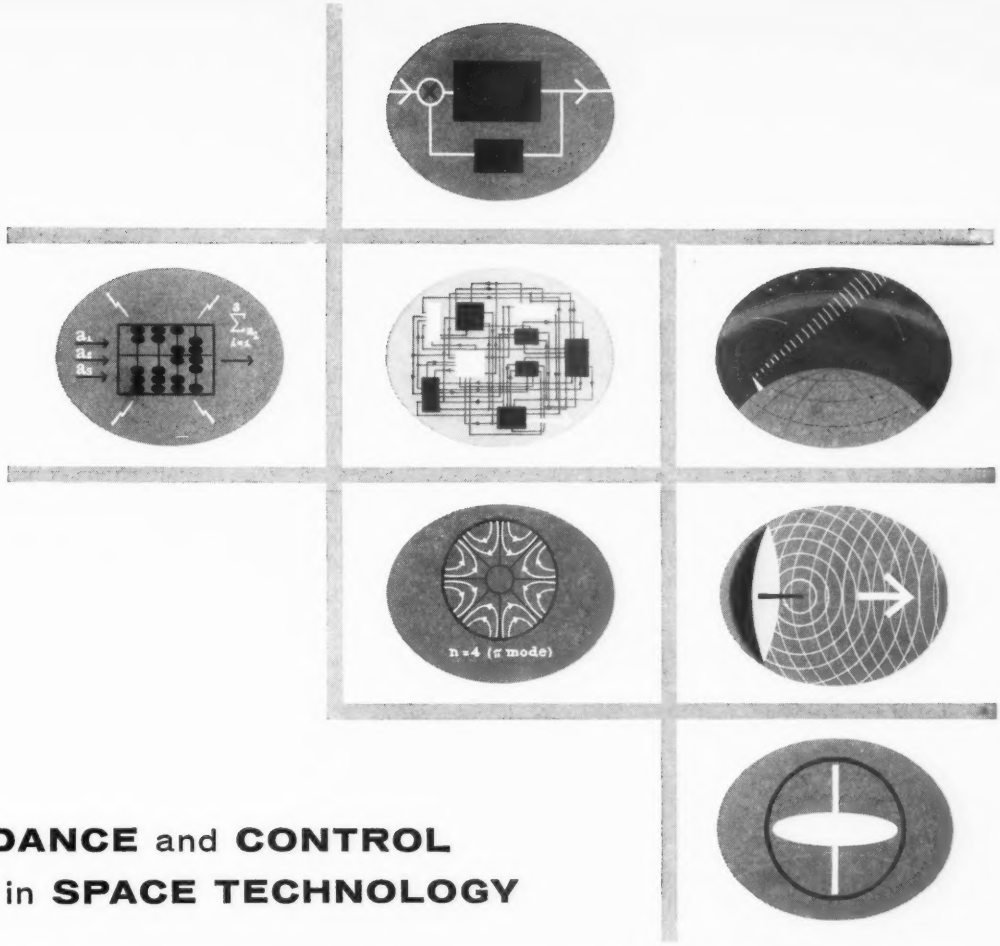
In the beginning of any development, over-all reliability will be low. In the event of highly complex equipment, such as a guided missile, it may be close to zero. The over-all reliability then grows very slowly according to a mathematically defined curve called a "growth curve." Two characteristic growth curves are shown on page 27.

The upper curve shows the growth of reliability of a simple missile consisting of only 100 components. Even so, it may take four years of development to attain an 80 per cent over-all reliability.

Reliability Growth Curve

The lower curve shows the growth of reliability of a missile consisting of 1000 components. In this event, three years may pass before even 1 per cent reliability is reached, and 10 years may be required to attain 80 per cent. Even this poor growth of reliability is overly optimistic.

Theoretically, over-all reliability of equipment should continue to grow until 100 per cent reliability is approached. Experience shows, however, that, after a certain stage of de-



GUIDANCE and CONTROL in SPACE TECHNOLOGY

It is becoming increasingly apparent that many of the techniques and analyses, and much of the equipment, developed for the present Air Force ICBM-IRBM programs will have a wide future application in space technology. For instance, many of the guidance and control techniques for ICBM's are applicable to the space vehicles of the near future.

An important element of these applications is precision. The precision required of the guidance and control system for vehicles aimed at the moon or one of the planets is not substantially greater than that required for the Air Force ICBM-IRBM programs. And, the precision needed to guide a vehicle into a near-circular orbit of Earth is even less than that required for ICBM's.

The problem of communication with lunar and planetary vehicles is, of course, made more difficult by the much greater distances involved. This, however, is not an insurmountable difficulty if today's trends continue in the use of higher transmitted power, narrower communication bandwidths and amplifiers with very low noise-figures.

The problems of operating electronic equipment in the space beyond our atmosphere are already encountered on present ballistic missile trajectories. The principal difference in the case of space vehicle applications is the requirement for longer equipment lifetimes. Electronic equipment and power supplies will have to last for several hours or days or weeks, instead of a few minutes, under conditions of vacuum pressure, zero "g" fields, and bombardment by micrometeorites, high-energy particles, and radiation.

The preceding examples serve to illustrate some of the ways in which the ICBM-IRBM programs are advancing the basic techniques of space technology.

Since 1954, Space Technology Laboratories has been providing over-all systems engineering for these programs. Both in support of this responsibility and in anticipation of future system requirements, the Laboratories are presently engaged in a wide variety of advanced analytical and experimental work directed toward the exploration of new approaches in space vehicle electronics, propulsion, and structures.

The scope of STL's work requires a staff of unusual technical breadth and competence. Engineers and scientists who are interested in advanced experimental development projects (as distinct from development for manufacturing, in which STL is not engaged) are invited to investigate the many opportunities on the Laboratories' Technical Staff.

SPACE TECHNOLOGY LABORATORIES

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velopment has been reached, the growth of over-all reliability slows down and becomes stagnant for years, perhaps forever.

This phenomenon, which may be called the reliability barrier, is illustrated by the dashed branches of the illustration. The simple missile consisting of 100 components may have its reliability barrier at 95 per cent, whereas a missile consisting of 1000 components may have its reliability barrier at only 42 per cent.

Reliability barriers are caused by two factors: First, by the employment of obsolete reliability concepts; and second, by insufficient reliability funds and efforts.

There is a widespread tendency to blame failures on poor manufacture, rather than on poor design. Yet it is an established fact that many more failures originate in immature design than in poor manufacture. This has its reasons. Designers (and the author is one himself) are more interested in achieving high performance, which is fun and glamorous, than in achieving high reliability, which is hard work and entirely unglamorous.

We should, however, give justice to the designer. Once he has finished a design, he is usually reassigned to another job with new and pressing schedules. Therefore he cannot follow his brain-child through all subsequent phases of production and usage, even if he were eager to do so. Moreover, once his component is in production, its design must be frozen. As a result, the designer is often helpless when he tries to introduce changes required to improve reliability.

Reliability Concepts Inadequate

Electronic equipment is particularly unreliable, primarily because of its great complexity, but also because the *concepts* of reliability employed in the design of electronics are inadequate to match this complexity. The principle of safety factors, for example, used to advantage in the design of structures and machinery, is virtually unknown.

The proof? A recent evaluation of the failures of one missile resulted in the following: 60 per cent of all failures were traced to failure of electronic components; 30 per cent to propulsion components; 7 per cent to booster components; and 0 per cent to airframe components!

One outstanding method for achieving the required "absolute" degree of design reliability is that of testing to failure. It says, in short, that every type of component, even if standardized and seemingly "very" reliable, must be mistrusted initially because it may be unable to stand the severe conditions occurring in a missile. In particular, it may not possess the "absolute" degree of reliability required for the components of very complex equipment, and may therefore become a potential killer of expensive missiles. Therefore, each component must prove its absolute design reliability before it can be admitted for employment in complex equipment.

To this end, a sufficient number of units of each type of component must be tested under increasingly severe conditions until failure occurs. Thus the critical "modes of failure" will be revealed. These modes of failure must be carefully studied and reported back to the designers of the component. Whenever safety factors between stresses and ultimate strengths appear to be inadequate for achieving the required absolute degree of component reliability, the component must be redesigned, again tested to failure, and possibly redesigned a second or third time.

In this manner, high safety factors, which in turn lead to ruggedness as well as long life, will be achieved.

Therefore, for maximum benefit, test-to-failure programs should be initiated at the very beginning of development, and conducted under highest priority as long as the equipment is being produced and is of importance to the Services. Since failure testing must be greatly stepped up, perhaps by a factor of 10 or more, the availability of highly skilled test laboratories may soon become the critical limiting factor of our missile program.

Manufacturing Reliability

Now let's take a look at manufacturing reliability. Once satisfactory design reliability has been achieved, it must be maintained in production. Quality control, and, in particular, statistical quality control, is the approved tool in this endeavor. However, the traditional yardsticks of "economy" must be changed entirely if we want to make complex equipment reasonably reliable. To the pocket book of a vendor, a component reliability of 99 per cent may appear quite satisfactory and economical. To the Armed Forces, however, such reliability is extremely unsatisfactory and costly.

If a missile is to become reliable and serviceable, each activity involved, beginning with preliminary design and ending with field operations, must consist of reliability-minded engineers.

We cannot expect all of the hundreds and thousands of engineers directly or indirectly involved in a missile project to have so much time to study the reliability problem that they can take care of it themselves. It is therefore advisable that all contractors concerned with such projects have an organization of highly skilled reliability engineers. They should be assigned to look into all matters involving reliability and to coordinate all reliability efforts arising during development, production and operation.

One might think that one centralized reliability organization would be most appropriate. However, since each activity in a project requires highly specialized skills, each activity should also have a reliability group of its own. It should be staffed by reliability engineers who, in addition to being experts in reliability, should also be experts in that particular field of technology.

These groups should be coordinated by a reliability coordinator whose professional background enables him to speak the language of all activities and who, at the same time, is a top expert in matters of reliability. It should be emphasized, however, that the reliability coordinator is by no means sup-

Suited for Space

XMC-2 full-pressure suit during checkout in high-altitude test chamber at Wright Air Development Center.

Looking remarkably conventional, the new Air Force XMC-2 full-pressure suit was recently given its first public showing. The suit will be worn during flights of the rocket-powered X-15, which is expected to reach altitudes of 40 miles and speeds close to 4700 mph.

During recent high-level discussions of space flight research held at the AF School of Aviation Medicine, ARDC's Brig. Gen. Donald Flickinger declared that the suit is capable of protecting fliers in an emergency anywhere in space, even on an expedition to the moon.

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from ½" to 30"ϕ

last the full burning time without cooling

NIAFRAX® nozzles are available in intricate shapes and can be produced to close tolerances in sizes ranging from ½" to more than 30" in diameter.

In uncooled rocket motors, NIAFRAX silicon-nitride-bonded silicon carbide refractories stand up to extreme temperatures, heat shock and erosion *for the full burning time.* In fact, NIAFRAX nozzles and liners will often last through several firings.

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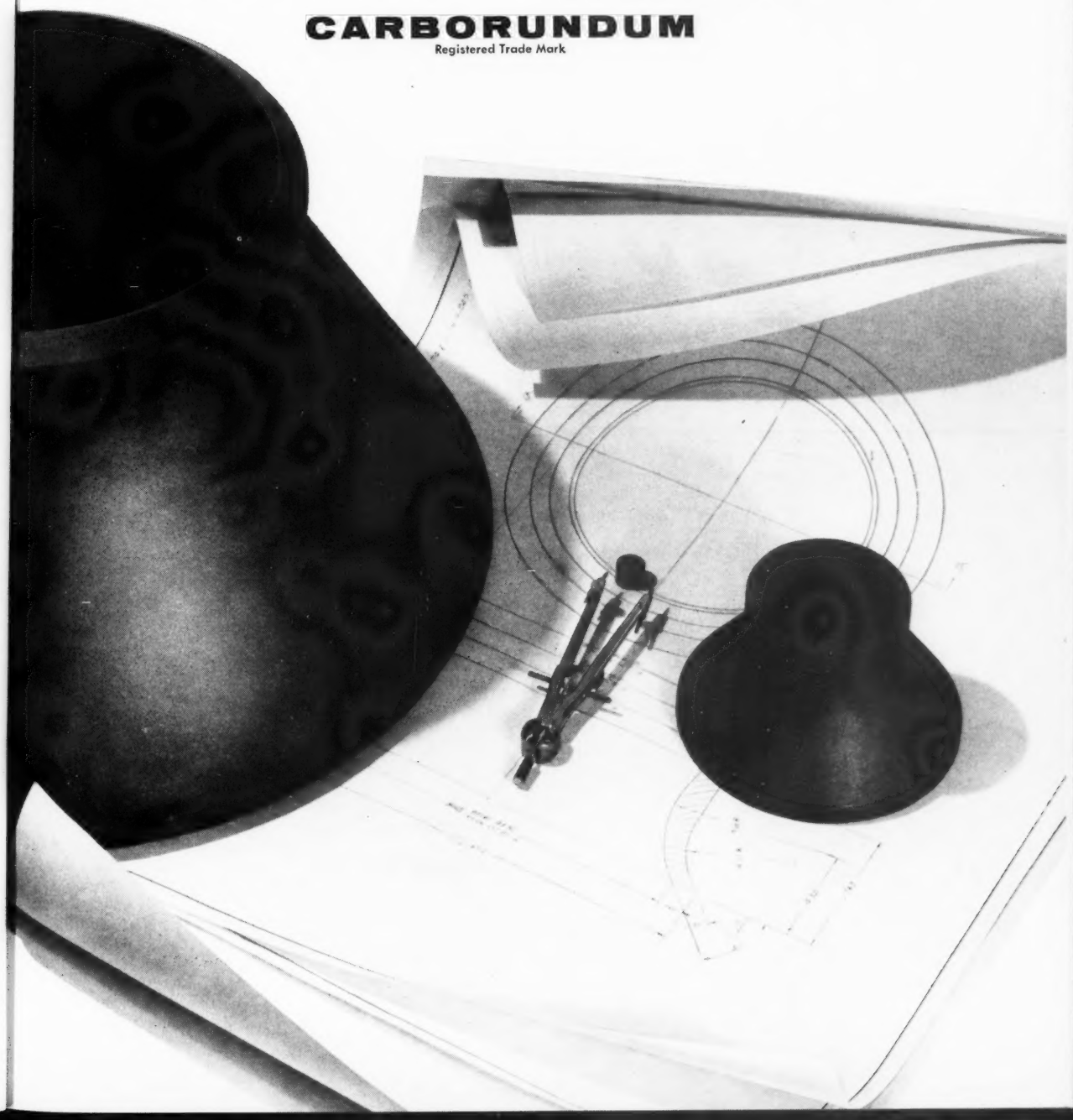


posed to duplicate the function of the chief engineer. His functions are entirely different.

Reliability programs obviously require a great deal of extra effort and must therefore be supported by adequate funds. The questions arise: What is adequate? Where is the point of diminishing return?

Part of the R&D funds in any project goes into the conventional R&D effort, part into the effort for achieving design reliability. Likewise, the main part of production funds is spent for producing all missiles, and a smaller part for maintaining reliability, as shown in the chart on page 26.

The cost of all missiles eventually may be broken down into two parts: "Good missiles," or those that eventually will hit the target, and "bad missiles," or those that will not.

The percentage of "good missiles" is identical with the over-all reliability. In the chart, this percentage is assumed to be 60 per cent.

Obviously, it is only the 60 per cent "good missiles" which interests the military. The 40 per cent "bad missiles" would better not be produced at all. Accordingly, the total expenditure of a missile program must be related to good missiles only, rather than to all missiles produced.

Economy Depends on Reliability

Thus it becomes evident that the economy of a missile program is strongly dependent upon the over-all reliability attained. For example, if all missiles were "good," that is, if over-all reliability were 100 per cent, the total expenditure per good missile would be at a minimum. As over-all reliability decreases, more and more money must be spent for "bad missiles," and hence the cost per "good missile" will increase by a factor, called the "Expenditure Factor" (ϕ). This is illustrated in the graphs on the bottom of page 27.

The lower graph shows the growth of over-all reliability as a function of the reliability effort. If the effort is weak, reliability will remain poor. The upper graph shows the expenditure factor as a function of the reliability effort. If reliability funds are scanty, the cost per "good missile" will pyramid, possibly becoming two, three or even 10 times as high as would be required if reliability funds were adequate.

With growing funds and efforts spent on reliability, the total expenditure factor decreases rapidly, reaching a minimum. Offhand, such a minimum might be interpreted as a point of diminishing return. But, since afterwards the curve rises only very slowly, it becomes evident that one may hardly spend too much for reliability.

If reliability funds are to have desired results, they must be spent wisely and efficiently. This in turn requires that all engineers directly or indirectly concerned with complex equipment and its components be capable of understanding and solving the reliability problems of their brain-children.

Thus reliability education becomes an urgent task in our missile program. It should be achieved using all means at our command.

Considering the many billions of dollars invested in our arms programs, we realize that the once neglected reliability program has assumed enormous dimensions. Playing ostrich regarding unreliability not only would be uneconomical, but downright dangerous.

If we don't lick the reliability problem, it will lick us.

Advanced Propulsion Systems Symposium Draws Crowd of 350

The Advanced Propulsion Systems Symposium co-sponsored by the Air Force Office of Scientific Research (ARDC) and Rocketdyne, and held in Los Angeles in mid-December, attracted a crowd of more than 350 scientists and engineers.

Co-chairmen for the symposium were Morton Alperin, director of advanced studies, AFOSR, and George P. Sutton, chief of preliminary design, Rocketdyne, and AMERICAN ROCKET SOCIETY President.

In addition to three technical sessions and a panel discussion, the symposium included a field trip to Rocketdyne's Propulsion Field Laboratory at Santa Susana and an unclassified dinner meeting at which Maj. Gen. J. W. Sessums Jr., Vice-Commander, HQ, ARDC, was the guest speaker. Gen. Sessums' topic was "Propulsion Research in the Space Age," and his address centered on AF research and development work in the past, present and future. S. F. Hoffman, Rocketdyne general manager, was toastmaster, while J. H. Kindelberger, board chairman of North American Aviation, of which Rocketdyne is a division, welcomed those attending the symposium.

The complete agenda for the meeting was as follows:

Thursday morning, Dec. 12—Technical session on advanced physical propulsion. Chairman: Arthur Kantrowitz, Avco Mfg. Co. Papers: "Ion Propulsion Systems," S. Naiditch, Aerojet-General; "Basic Considerations in Electric Thrust Devices," Gabriel Giannini, Giannini Research Laboratory; "Ion Rocket Engine," Robert H. Boden, Rocketdyne; "Comparison of Advanced Propulsion System Solar Heating, ARC Thermodynamics and ARC Magneto Hydrodynamics," Krafft Ehricke, Convair-Astronautics; and "Thrust from Plasma," W. H. Bostick, Stevens Institute of Technology.

Thursday afternoon—Technical session on advanced physical propulsion and Power Sources. Chairman: Lt. Col. Paul G. Atkinson, USAF. Papers: "Closed Cycle Gas Turbine," R. D. Buhler, Giannini Research Laboratory, and L. R. Woodworth, Propulsion Research Corp.; "Speculation about Future Trends in Lightweight Electrical Machinery," R. A. Koehler, General Electric Co.; "Direct Power Conversion," John Huth and George Safonov, Rand Corp.; and "Electrostatic Generators," A. John Gale, High Voltage Engineering Corp.

Friday morning, Dec. 13—Panel discussion on high-energy propellants. Chairman: T. F. Dixon, Rocketdyne. Panel members: R. J. Rosa, Avco Mfg. Co.; John F. Tormey, Rocketdyne; W. H. Avery, Applied Physics Laboratory, Johns Hopkins; Col. E. N. Hall, USAF; J. M. Carter, Carter Laboratories; D. L. Armstrong, Aerojet-General; and H. J. Stewart, Jet Propulsion Laboratory, California Institute of Technology.

Friday afternoon—Technical session on high-energy propellants; Chairman: Weldon Worth, Propulsion Laboratory, WADC. Papers: "Stabilized Free Radicals," J. L. Jackson, National Bureau of Standards; Research on Free Radicals as Rocket Propellant," George Moe, Aerojet-General; "High-Performance Solid Propellants," C. D. McKinney, Allegany Ballistics Laboratory; "High-Performance Liquid Propellants," John Sloop, NACA Lewis Flight Propulsion Laboratory; and "System Considerations Affecting New Propulsion Applications," A. F. Donovan, Ramo-Wooldridge Corp.

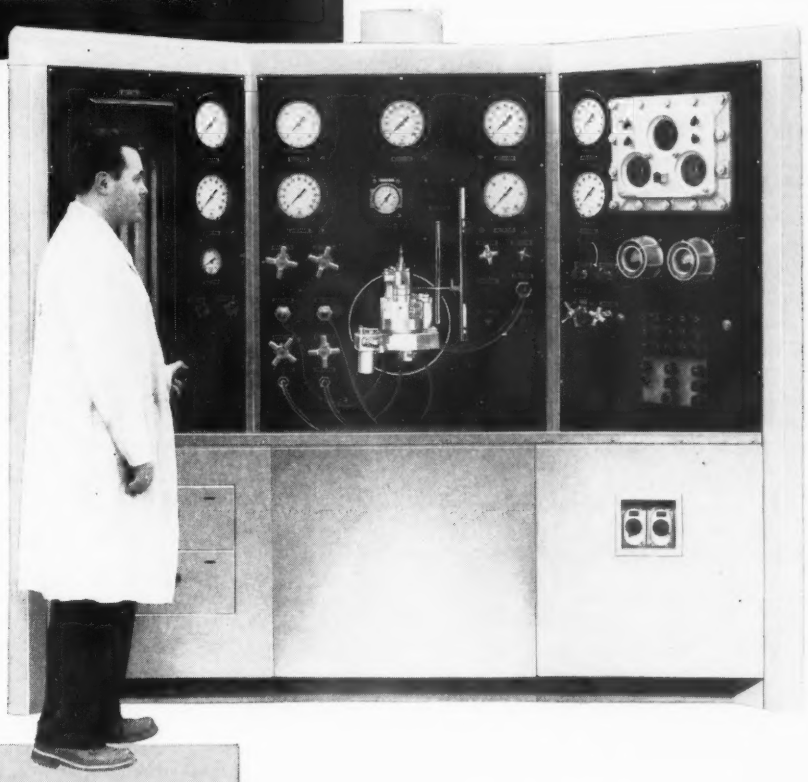
Sylvania Developing Plato, New Anti-IRBM Missile

Latest missile to be announced is the Plato, a new weapon designed to intercept and destroy enemy missiles which is now under development at the Waltham, Mass., missile system laboratory of Sylvania Electric Co. The missile is expected to be able to halt enemy IRBM's. No technical details have been announced as yet.

The Plato is the fourth anti-missile missile system, the others being the Army's Nike-Zeus, the AF Wizard and another, as yet unnamed AF project.

CONTROLLED ACCURACY TESTING

of FLOWS and PRESSURES of LUBE OIL, FUEL, VACUUM and AIR for JET ENGINE CONTROL ISLANDS



This Testing Console, designed and built by Sun for Continental Aviation and Engineering Corporation, is used to check out the Control Island Fuel System of Continental Models MA-1 and MA-1A Air Compressor Engines, prior to assembly in jet engines.

A complete control island assembly is mounted on the tester drive pad while fuel, lubricating oil and air are delivered under simulated operating conditions. Fuel/oil flow and pressures are accurately controlled and temperatures regulated throughout the full operating range. Typical of the many specialized testing units produced by Sun, we invite you to present your testing equipment problems to Sun engineers. Our extensive experience in this field, comprising expert engineering and production facilities are at your disposal.

FEATURES

The specific requirements of this tester involve a number of unusual features, among them: • source of vacuum and regulated air supply • fuel flow controlled by remotely-operated regulator valves from panel loaders • pneumatically-operated fuel temperature control which functions automatically at designated preset temperature • mechanically operated oil temperature control • non-corrosive stainless steel fuel reservoir and water-cooled heat exchanger • explosion proof components • full ventilation and Underwriter's approved safety standards.

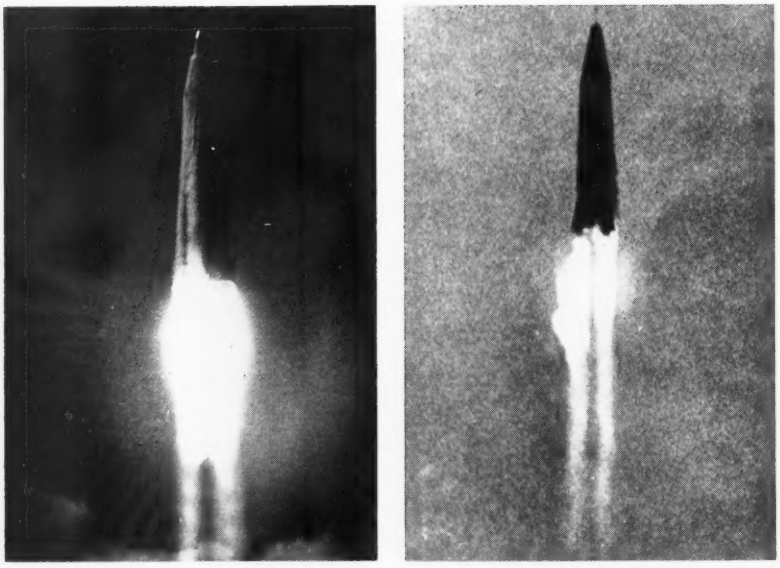
LEADING PARTICULARS

FUEL:	Specification	MIL-F-7024 Type 2
	Flow	15 gpm at 50 psi—5 to 1200 pph with valving and piping capable of 5 to 2000 pph
	Reservoir Capacity	30 U.S. gallons
	Temp. Control	Accurate to ±0.5 degrees
OIL:	Specification	MIL-O-6081B
	Flow	Gravity feed
	Reservoir Capacity	12 U.S. gallons
VACUUM		28 in. at 0.6 cu. in. per min.
AIR		30 and 50 psi
DRIVE		Variable, 5 hp electric motor
SPEED RANGE		3000 to 11,000 rpm
ACCURACY		±¼ of 1% full range
ELECTRICAL REQUIREMENTS		220/440 v, 3 ph, 60 cy AC
GAGES		Accurate to ½ of 1% full scale

Sun ELECTRIC CORPORATION

CHICAGO AERONAUTICAL DIVISION: 6325 Avondale Ave., Chicago 31, Illinois
LOS ANGELES AERONAUTICAL DIVISION: 6703 Sepulveda Blvd., Los Angeles, California

If At First . . . .



In its first test flight last June (left), Atlas ICBM got off the ground, but not far enough off. A second test flight also aborted. But last December, the Air Force made it on the third try (right). The missile flew its prescribed, foreshortened course and landed in the preselected impact area. More important, the vehicle sent back valuable information, involving up to 250,000 separate data points.

Push-Button Rocketry

(CONTINUED FROM PAGE 45)

launchings, the field crew consisted of five or six men, who handled instrument preparation and installation, communications with observatories, monitoring of radio fadeout, launching the rockets and recording telemetered signals. Because of the relative infrequency of large flares during July and August, the field teams operated on an 11-hr day, seven-day week schedule for most of the summer. During each day's watch on the sun, the crew had to be on continuous alert to respond to a sudden flare. As many as a dozen flares sometimes occurred in a single day without producing one sufficiently interesting to fire on. Since the flash phase of a flare is so short, the scientist responsible for the decision to fire had to quickly judge the magnitude of a reported flare from the running descriptions radioed by solar observatories and the signal strengths indicated on his fadeout receivers. The decision to fire had to be made within a matter of one or two min.

In reviewing results of the program thus far, it is clear that the "push-button" problems of the experiment were successfully solved. The rocketeers on the project expressed gratitude to W. O. Roberts of Climax, J. Evans of Sacramento Peak and I. S. Bowen of Mount Wilson for making their staffs and facilities available to assist in the flare detection problem. A continuous running account of solar weather and flare predictions from the observatories greatly relieved the tensions of prolonged waiting on the island. The site prepared by the NMTC was ideal for launching operations and the Navy made every possible concession to assure elimination of interference with the firings. On the occasions of only two flares was it necessary to hold fire and then merely because of ships on the firing line.

The scientific results of the program to date are of considerable interest. It appears that each flare capable of producing an ionospheric disturbance is accompanied by a flash of X-rays. Solar X-rays are believed to originate in the extremly hot, tenuous outer atmosphere of the sun known as the corona. This coronal gas, normally at a temperature of about 1 million C, is the hottest visible material in the universe. Flare X-rays are of much shorter wave length than those emitted by the quiet sun. To account for the rocket observations of flare X-rays, the local coronal temperature in the vicinity of very large flares must exceed 10 million C. The shortest X-ray wave lengths observed thus far are similar in quality to the radiation from an X-ray tube operated at about 6000 volts.

At the present time, one instrumented rocket remains to be fired at San Nicolas Island. It will utilize an Asp rocket in place of the Deacon. The higher performance expected of the Asp should provide two to three times longer flight and proportionately more data above the D-region of the ionosphere. New instrumentation is now being designed and may be utilized in further launchings from San Nicolas Island this Spring.

The feasibility of "push-button rocketry" has opened up possibilities of many other interesting geophysical experiments. NRL is now preparing to participate in the IGY program for the October, 1958, solar eclipse which will pass over the Danger Islands in the Southwest Pacific. As the eclipse progresses through its various phases, six to eight instrumented rockets (Nike-Cajuns or Nike-Asps) will be fired in sequence from the deck of a ship in the space of approximately 4 min. The launchings will be accurately coordinated with the moon's passage before the sun to provide data on the distribution of emitting centers of ionizing radiations on the solar disk and in the corona.

Churchill Firings Uncover 300-Mile Winds 60 Miles Up

A series of five Aerobee-Hi rocket firings carried out under the IGY program last summer at Fort Churchill, Manitoba, Can., has revealed that 300-mile winds are common at altitudes of 60 miles and temperatures drop to −100 F at these altitudes. The rockets were fired by physicists from the Army Signal Engineering Laboratories, Fort Monmouth, N. J., using the grenade technique.

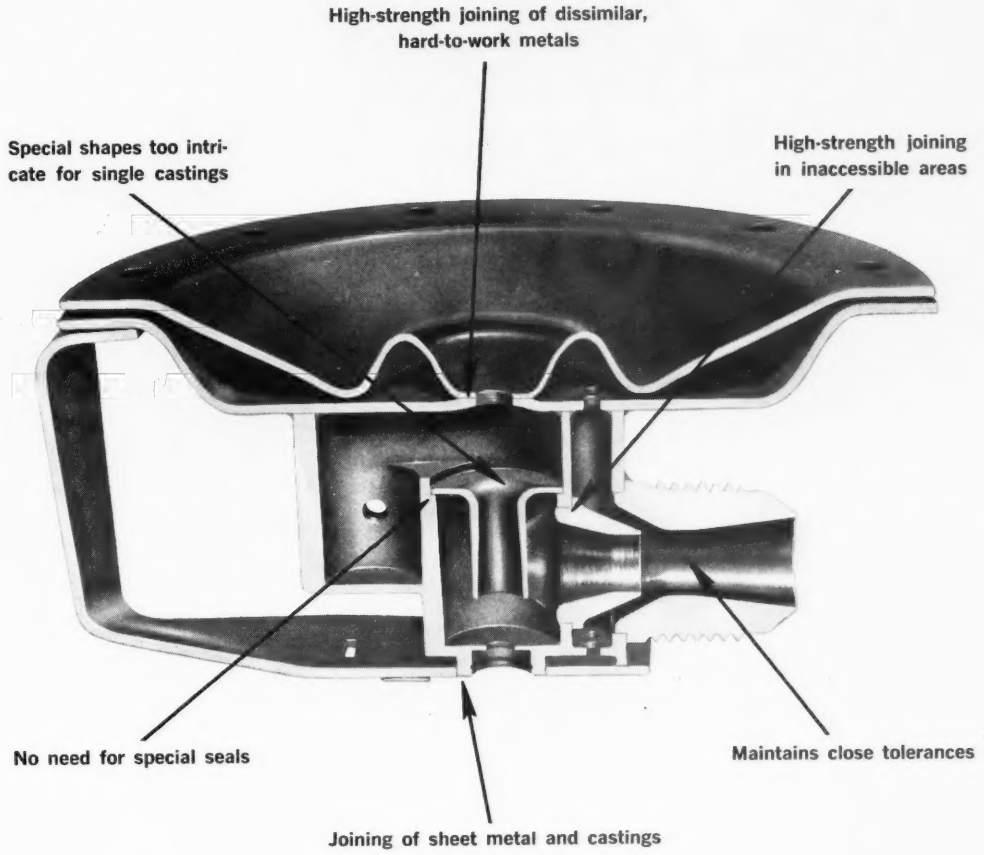
Fellowships to be Awarded

Eighteen to 20 Daniel and Florence Guggenheim Fellowships will be awarded in 1958 for graduate study at Princeton University, California Institute of Technology and Columbia University.

The Fellowships are awarded annually to outstanding graduate students residing in the U. S. and Canada for study at the Jet Propulsion Centers at Princeton and Cal Tech, and the Institute of Flight Structures at Columbia. They carry stipends of $1500 to $2000 each, plus tuition.

The grants are designed to select and train outstanding men for basic research in rockets, jet propulsion, and other flight structures.

Solar advanced brazing technology offers these advantages


High-strength joining of dissimilar, hard-to-work metals
Special shapes too intricate for single castings
High-strength joining in inaccessible areas
No need for special seals
Maintains close tolerances
Joining of sheet metal and castings

THIS INTRICATE CONTROL UNIT demands utmost precision—in design, manufacturing and assembly. That's why Solar engineers planned the entire unit for high-temperature brazing. This advanced joining method produces lighter, stronger, more compact components—faster, and at less cost.

Lightweight aircraft and missile components, for example, can be made to withstand higher temperatures than those at which they were brazed. And they can be made from dissimilar metals and high alloys that are *right* for high-temperature applications.

Effectiveness of this advanced assembly process has been proven by years of experience. If you would like to know how Solar can apply this design and brazing experience to your particular manufacturing problem, write to Dept. D-128, Solar Aircraft Company, San Diego 12, California.

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DESIGNERS, DEVELOPERS AND MANUFACTURERS of gas turbines, expansion joints and aircraft engine, airframe and missile components.

Republic to Market French Helicopter

FRANCO - AMERICAN WHIRLY-BIRD-Alouette II, gas turbine-powered helicopter, is being marketed in America by Republic Aviation Corp.

Under a licensing arrangement, the Alouette II, jet-powered French helicopter introduced to this country last Spring, is being assembled and marketed in this country by Republic Aviation Corp. from French-built components.

Eventual production of Alouettes by Republic will follow a phase of gradually entering into manufacturing by domestically producing an increasing number of components to be integrated with French production.

Soviet Instrumentation

(CONTINUED FROM PAGE 33)

amplifiers, counting stages, information storage, programming and telemetering. High voltage for the S.E.M. tubes is obtained from d.c.-d.c. converters, presumably transistorized, and is stabilized by a corona discharge voltage regulator tube. (No description of the power supply is contained in the Mandel'shtam-Yefremov paper, but other Russian publications describe such power units in connection with cosmic ray experiments for satellites.) Pulses from the S.E.M. tubes are fed to an amplifier, pulse shaper and counting circuit. Three ranges of counting rates are employed—500 cps, 5000 cps and 50,000 cps. Outputs of the counters are converted to d.c. signals. The information is fed to a storage circuit and telemetered according to a preprogrammed time pattern. No details of satellite circuitry for such operations are given, but elsewhere the Russians have described transistorized counting circuits for rates up to 50,000 cps.

Mandel'shtam and Yefremov also revealed that only one of the three detector units is operative at any time. The instrumentation is activated when light from the sun hits one of the detector tubes. Associated with that unit is a pair of photoresistors, one responding to a 120 deg field of view, the other to a 60 deg field. The former energizes the filament circuits, the latter the B and high voltages. The filter disks rotate at such a speed that each filter is in position for half a second.

From the photograph of the filter disk, it appears that there are about 16 apertures on the periphery. If one measurement comprises a complete turn of the wheel, this would cover eight sec. During this interval the satellite would not be expected to turn through more than 60 deg. One may conclude that Sputnik II was not intended to spin any faster than perhaps one rpm.

U. S. Techniques Compared

How does the above description of the Soviet experiment compare with techniques used in the U. S. upper air research program? Virtually all the X-ray data available in the scientific literature are based on Naval Research Laboratory measurements. We have used photon counters with windows or filters of Be, Al and Mylar to achieve the transmission characteristics illustrated in the graph on page 33. The Russian plan adapts the approach used in U. S. rocket experiments to their satellite, with the substitution of S.E.M. tubes for detection and scaling circuits in place of thyratron rate meters. The Russians suggest that utilization of the same detector tube for all measurements guarantees the accuracy of comparisons of measurements through the different filters. It might also appear to be an advantage to have the entire detection apparatus open to vacuum, since this eliminates any possibility of damage to the detectors from meteor puncture. Gas-filled tubes such as used by NRL would fail on puncture. On the other hand, puncture of any of the filters in the Russian apparatus would be fatal to their experiment, since the S.E.M. tubes would respond strongly to light leaks.

In the August, 1957, issue of ASTRONAUTICS, an article by the writer on "The Vanguard Instrument Package," describes the U. S. experiment intended to measure solar Lyman Alpha. With the ion chamber developed for this purpose, it is not necessary to chop the solar spectrum between a pair of filters. The narrow band sensitivity is inherent in the design of the tube. The efficiency of the detector is so high that a comparatively simple current measurement is required.

Solar X-ray and ultraviolet radiation experiments are among the most interesting fundamental measurements that can be made from satellites. Assuming that the Russian experiments have been successful, scientists are awaiting the publication of their results with great interest. When the U. S. succeeds in launching its solar radiation experiment, the apparatus is so designed that data will be telemetered continuously and will be relatively easy to receive and interpret anywhere under the orbit of the satellite.

It is difficult to make much detail out of the photograph of the cosmic ray apparatus or to fit it into the description published by the Russians of their planned experiments. Translations of Soviet newspaper accounts of the experiment mention halogen detectors. The reference undoubtedly is to a halogen-quenched type of Geiger counter. (Such a tube will be used in the State University of Iowa cosmic ray experiment, now being fitted to the Jupiter C missile.)

The photograph of the instrumentation shows what appears to be a Geiger tube about 5 in. long and about $^3/_4$ in. diam. The + marks the anode connector. The ribbed structure of the shell indicates a thin walled tube. If the background structure is the electronics chassis, it would appear to use vacuum tubes rather than transistors, and the hardware resembles typical laboratory construction without any obvious effort at miniaturization.

One published description of Soviet plans for a cosmic ray satellite experiment calls for two Geiger counters oriented at right angles to each other, with one tube located remote from massive portions of the satellite. In addition the experiment would include a pressurized ionization chamber 1 ft diam. Briefly, the proposed objective was to measure both the total number of particles and the total ionization in such a way as to derive the number of highly ionizing heavy components of the primary cosmic rays, as well as the total flux. It is difficult to see any resemblance between the proposed experiment and the photo on page 33. Either the photograph illustrates only a portion of the apparatus or the experiment in Sputnik II is no more elaborate than the S.U.I. experiment to be flown in the U. S. program.

Flight Test Instrumentation Symposium Set for May 4-7

The fourth national Flight Test Instrumentation Symposium will be held at the Park Sheraton Hotel in New York City May 4–7. The theme will be "More Data per Dollar." Information concerning the symposium may be obtained by writing to P.O. Box 113, Bethpage, Long Island, N. Y.

Cost of Atlas ICBM Put at $2 Million

An Atlas ICBM will probably cost about $2 million once the missile goes into production, according to J. R. Dempsey, general manager of Convair-Astronautics, which is building the vehicle for the Air Force.

Dempsey gave the estimate, which does not include the cost of the thermonuclear warhead, at a special briefing on missiles for the press arranged by the Air Force Assn. in Washington, D. C., in mid-December, and attended by 200 newsmen from all over the country.

He also said the Atlas was capable of launching satellites weighing from 500 to 1000 lb and predicted the Defense Department would shortly issue orders assigning a satellite-launching mission to the missile.

Dempsey was a member of a panel which also included George P. Sutton, chief of preliminary design at Rocketdyne and President of the AMERICAN ROCKET SOCIETY; Morton Price of AC Electronics Div. of General Motors; Arthur Kantrowitz, vice-president of Avco Mfg. Co.; Peter J. Schenk of General Electric Co.; and George S. Trimble, vice-president of The Martin Co.

Price told newsmen present at the briefing that the first successful flight test of an all-inertial guidance system in an IRBM had been accomplished in a recent Thor firing.

Convair Running New Thermal Tolerance Tests

An experiment to test human tolerance to thermal stress and high noise levels is being carried out through the cooperative effort of the human factors staff and the aviation and space medicine group at Convair-San Diego.

Experimental conditions differ from those of previous studies in that an actual cockpit environment is utilized for the test chamber. Also, cockpit walls are maintained at a temperature far greater than that of cockpit air, whereas previous studies have been performed under conditions of nearly equal wall and air temperatures. While exposed to the heated environment, the pilot is required to perform a psychomotor task of complexity similar to that encountered in operating an aircraft. By closely reproducing the actual conditions of noise, thermal and geometrical environment to which a pilot is exposed, measurements of tolerance times under simulated flight conditions can be studied.

Through a complicated arrangement of monitoring systems, simultaneous measurements of psychomotor performance, EKG tracing, blood pressure, pulse, respiration, and skin and internal body temperatures are recorded during the experimental run. By these means, it is possible to determine the length of time that an individual can tolerate these stresses before any falling off in his performance level results. This information is in turn utilized by the engineering design groups as design parameters for the aircraft. The work is particularly appropriate to high Mach number and re-entry aircraft.

In charge of the study are E. G. Aiken, of the human factors staff, principal investigator; R. C. Armstrong, of the aviation and space medicine group, physician in charge; and Jack Lowe, of the dynamics test laboratory, technician in charge.

Capt. Grover J. D. Schack
ARS Human Factors Committee

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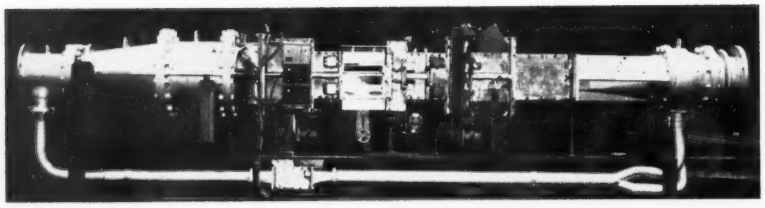
Amrad Supersonic Wind Tunnel



The Varitunnel, a 14 ft. long supersonic wind tunnel, will be installed at Case Institute of Technology.

The Varitunnel, a new supersonic wind tunnel, was placed on display recently at the Busch-Sulzer Div. plant of Nordberg Mfg. Co. The tunnel employs several components produced by Nordberg for the manufacturer, Amrad (Aeronautical Missile Research and Development Inc.) of Sewanee, Tenn. The tunnel will be shipped to Case Institute in Cleveland, Ohio.

The Varitunnel is made in test section sizes ranging from 2 by 2 to 12 in. as a complete assembly ready for installation in the customer's air-supply circuit. These units are suited for educational and research applications. The standard semiflexible nozzle offers continuous and rapid variation of Mach number in the range 1.25 to 3.80 with a maximum deviation less than ± 1 per cent of the nominal value throughout the range.

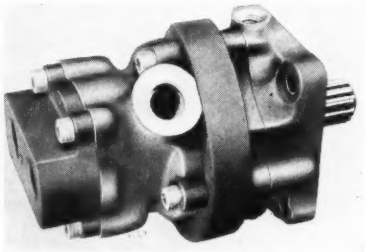
The diffuser utilizes the inherently simple nozzle operating principle to obtain a gradual supersonic compression region upstream of a long stabilizing throat. Rotation of a single shaft automatically establishes the entire second throat configuration, consisting of a contoured contraction region, a slightly divergent minimum area passage, and a divergent subsonic diffuser.

Test and sting support sections permit unhampered access to the test model. The test section contains full height Schlieren windows permanently bonded in machined metal frames which are test retractable vertically by means of a hand wheel mechanism. Similarly, a panel in the wall of the sting support section may be removed to expose the double wedge arc. A detachable cover on this arc allows easy threading of test model pressure tubing and electrical leads.

Electric motor drives with integral gear boxes are provided for positioning the variable nozzle walls, angle of attack sector, and diffuser walls. Units are provided for either ac or dc service. Geared counters provided on both nozzle and diffuser actuating mechanisms indicate the respective throat openings. Integrated nozzle-diffuser control systems permitting automatic selection of Mach number may be obtained as optional equipment.

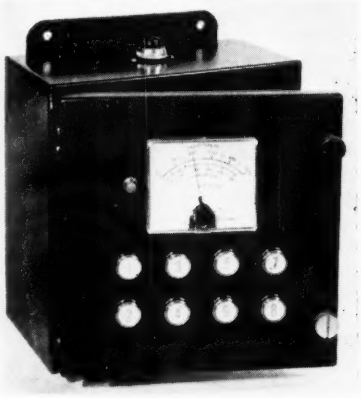
EQUIPMENT

Pump for Corrosives: The Kemlon pump is a diaphram-type unit designed to handle corrosive fluids. Available in both simplex and duplex models, they feature suction lifts up to 20 ft, with standard design pressures of 50 psi and much higher pressures available for special applications. Keystone Engineering Co., P. O. Box 14366, Houston 21, Tex.



Cryogenic Pump: Sundstrand-Denver has developed a compact, lightweight, piston type aircraft pump suitable for pumping liquefied gases such as nitrogen and oxygen. The pump is capable of pumping liquid nitrogen at pressures of over 3000 psi at speeds of over 3500 rpm. Sustained operation for more than one hour has been obtained repeatedly without lubrication. Displacement, 0.130 cu in./rev; capacity at 3500 rpm, 1.75 gpm; horsepower at 3500 rpm, 3.8; hp; weight, 2.5 lb. Application Engineering Dept., Sundstrand-Denver, 2480 W. 70th Ave., Denver 11, Colo.

Environmental Connector: Widely used in missiles, a new type environmental miniature connector features a simple, positive automatic locking device. An orange band is visible when the connector is disengaged. A resilient inter-facial gasket between the plug and receptacle mating faces is compressed when the connector is locked, and a resilient grommet is compressed in the rear of the plug and receptacle after soldering. Viking Industries, Inc., 21343 Roscoe Blvd., Canoga Park 1, Calif.



Temperature Scanner: The Tripptronic multipoint temperature scanner provides over-temperature or under-temperature protection for systems which require a temperature alarm instrument capable of sensing several control points and giving notice when temperature exceeds or fails to reach a pre-set limit. Thermocouples, which may range from 4 to 56, are connected to a stepping switch which samples the output of each thermocouple. This signal is then delivered to the signal terminals of a contact meter. Tipptronic, Inc., Chagrin Falls, Ohio.

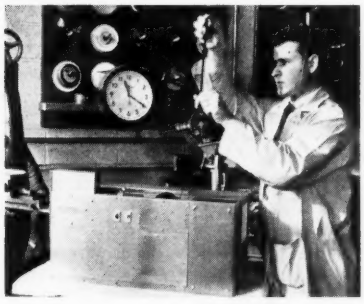
●

Missile Cleaning: Approved facilities for cleaning and packaging missile components is announced by Zep Aero. The new service is designed to eliminate contamination of liquid oxygen, hydrogen peroxide, sodium reactors and fuel components. Hydrogen peroxide activity checking is also available. Zep Aero, 113 Sheldon Ave., El Segundo, Calif.

●

Silicon Solar Battery Cells: Solar cells for efficient conversion of light

and radiant energy into electrical power of useful proportions, measuring approximately 1-in. diam, are available in mounted and unmounted types. Mounted cells have black phenolic housings with a glass window. Mounting studs also serve as electrical output terminals. Unmounted cells are supplied with 6-in. color-coded insulated leads. International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.



Portable Film Processor: An automatic, self-feeding, rapid film processing device able to develop dry 16 mm film at the rate of up to 10 fpm is now available. The Mini-Rapid 16 develops an ordinary 100 ft roll of film and has it ready for projection within 20 min after shooting. Major elements in the processor, about the size of a standard file drawer, are easily interchangeable film transport plastic inserts containing a high-speed developer, a rapid fixer, a hypo eliminating agent and a static rinse. Drying is carried out by a high velocity air jet. Industrial Camera Div., Fairchild Camera and Instrument Corp., Syosset, L. I.

●

Vibration Mountings: Bonded rubber vibration and shock control mountings can now be produced to operate efficiently at a broad temperature range with minimum changes in physical properties. Transmissibility at resonance is 3 or less at 68 F; at 300 F, it is less than 3.5. The elastomer is resistant to oil and ozone, and has unusually high tensile strength. Lord Mfg. Co., 1635 West 12th St., Erie, Pa.

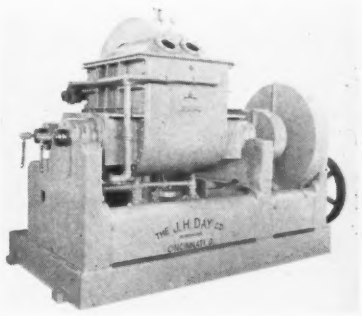
Dynamic Accelerometer: A self-generating accelerometer, capable of handling accelerations to 1000 g, is now available for missile and aircraft applications where high-frequency transients or step-function inputs are expected. Type 4-240 operates over a frequency range of 3 cps to 60 kc, and has a flat response of ±6 per cent between 5 cps and 40 kc. Acceleration range is from 0.01 g to 1000 g. Transducer Div., Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

●

Computer Center: Model MC-400 is a precision, portable, desk-side unit with all facilities necessary for process design computation in such fields as guided missiles, heat exchangers, catalytic cracking, proportional mixing, etc. Made up of 12 operational amplifiers, 16 scale factor potentiometers, one servo multiplier, four free diodes, two relay amplifiers, a vacuum tube voltmeter, two channel oscillographic recorder, and built-in power supplies, the MC-400 has been engineered for maximum accessibility and minimum operator error. Mid-Century Instrumatic Corp., New York, N. Y.

●

Silicone Fluid: Versilube fluids, designated 81717 and 81644, provide greater flexibility than was previously possible in the design of hydraulic and engine lubrication systems for aircraft and missiles. Primarily intended for use in hydraulic systems, No. 81717 can withstand prolonged use over the −65 to 575 F temperature range. Fluid 81644 is for use in engine and other lubricating systems where exposure to air cannot be controlled. This material remains stable under exposure to oxygen at temperatures as high as 510 F. Silicone Products Dept., General Electric Co., Waterford, N. Y.



Dispersion Mixers: Specially designed Day dispersion mixers incorporate many unique engineering and construction features. The 100-gal working capacity model has a total capacity of 200 gal, and is designed for 75 hp drive. Vacuum seal stuffing boxes prevent contamination. H. H. Day Co. Div. of Cleveland Automatic Machine Co., Cincinnati 12, Ohio.

●

Hi-Temp Switch: The new basic S9-4 switch provides precision tolerances in an ambient temperature range of −100 to +900 F. The ceramic case contains the standard Electro-Snap switch mechanism for single-pole, double-throw, two-circuit electrical controls. Staggered screw terminals, of stainless steel, permit easy wiring. Electro-Snap Switch & Mfg. Co., 4218 W. Lake St., Chicago 24, Ill.

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Miniaturized Coupling: Designed for precision coupling requirements in servo and instrument applications, the Maxflex coupling accommodates radial, axial and angular misalignment in connecting shafts, motors and components, without backlash or error. Available in $^1/_4$ in. male, and $^1/_8$ and $^3/_{16}$ in. female types. Parametrics, P. O. Box 629, Costa Mesa, Calif.

●

Servosystems Worksheets: Servoscope Servosystems analyzer worksheets are transparent masters from which almost any kind of photographic duplicator will produce a supply of work forms as required. These forms provide a standardized permanent record of the system or component under test. Servo Corp. of America, 20-18 Jerico Turnpike, New Hyde Park, N. Y.

PRODUCTS

Fabrication of Teflon: Limited production with the new du Pont thermo-

plastic Teflon 100-X perfluerocarbon resin has been announced by U. S. Gasket. Pilot production in both extrusion and injection molding has indicated qualities which will permit many new products and production economies. United States Gasket, Plastics Div., the Garlock Packing Co., Camden, N. J.

●

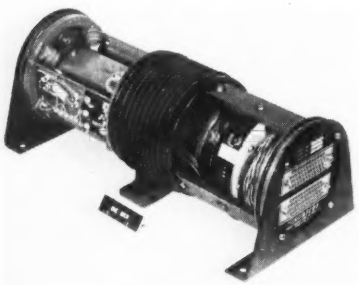
Explosive Switch: A compact explosive switch with shock and vibration resistance has a response time of 100 micro-sec. Input leads open positively after firing signal. Contacts are insulated for potentials to 1000 v, rated for 10 amp continuously and momentary currents of 100 amp. Available in single-pole, double-throw or single-pole, single-throw types. Raymond Engineering Laboratory, Smith St., Middletown, Conn.

●

Titanium Alloy: Ti-155A titanium alloy has high-strength heat treat capabilities up to 170,000 psi. The alloy also offers stability through temperatures of 750 F, good creep properties and improved endurance limits. To match this performance, steel of similar weight would have to provide tensile strengths of about 255,000 psi. Titanium Metals Corp. of America, 233 Broadway, New York 7, N. Y.

●

Missile Skin Stretcher: A biaxial stretch-forming machine, for use in forming integrally stiffened missile skins, handles wider and heavier sheets in which the stiffening ribs have been extruded, and holds close tolerances. Sheet sizes up to 5 by 24 ft are accommodated and ample force is supplied to form 2014-T4 aluminum up to 14 sq in. cross-section longitudinally and 46 sq in. cross-section transversely. Hufford Corp., 1700 E. Grand Ave., El Segundo, Calif.



Low Level Multicoders: Supersensitive ASCOP D series low-level multicoders are used for missile and aircraft flight instrumentation in the low 0–15 and 0–30 microvolt ranges. This development makes possible multiplexing and coding of up to 86 low-level sources by the use of a miniaturized packaged assembly. The multicoders are capable of discerning signal magnitudes as low as 75 microvolts and are suited for applications where large numbers of low level data sources must be sampled sequentially. Applied Science Corp. of Princeton, P. O. Box 44, Princeton, N. J.

●

Glass-Kel-F Materials: Higher strength at temperatures approaching absolute zero and greater rigidity at 425 F and above are claimed for Fluoroglas and Fluoromat materials using Kel-F. Materials of this type are effective as liquid nitrogen or oxygen seals, high-temperature diaphragms, and for other uses. Virgin Kel-F plastic provides exceptional chemical inertness and dielectric properties and good mechanical properties at temperatures from −320 to 390 F. Fluorulon Laboratories, Inc., P. O. Box 305, Caldwell, N. J.

●

Quick-Disconnect Coupling: Remotely operated quick-disconnect couplings for use in aircraft and missiles are produced in sizes from $^1/_4$ to 2 in. i.d., and disconnect by means of compressed air, electrical solenoids, lanyard, pullaway (or breakaway), as well as combinations of these methods. Couplings up to 10 in. i.d. and larger are also produced to handle compressed air and gases, ordinary and exotic fuels. On Mark Couplings, 4440 York Blvd., Los Angeles, Calif.

●

Landing Gear Actuator: A propellant-energized emergency landing gear uplock actuator, weighing only 0.27 lb, provides a simple and inexpensive means of lowering landing gear in the event of failure of the hydraulic or pneumatic system. In the event of failure of the hydraulic or pneumatic system which normally actuates the uplock mechanism, the propellant cartridge seals off the normal system and supplies sufficient gas to the uplock cylinder or cylinders to unlock the gear, allowing it to free-fall into position. Propellex Chemical Corp., Edwardsville, Ill.

●

Subminiature Resistor: Smallest precision wire-wound resistor in a full line of axial resistors, the NS6AZ (0.125 by 0.250 in.) is one of over 15 sizes encapsulated to meet military specifications. Available with resistance values up to 125 K with tolerance to 0.1 per cent, this resistor will dissipate 0.1 watt at 125 C. Eastern Precision Resistor Corp., 675 Barbey St., Brooklyn 7, N. Y.

●

Nonleakage Seals: Leakproof static seals with full metal-to-metal contact are being produced for sealing in a wide range of fluids at pressures from vacuum to more than 5000 psi and temperatures from −80 to 500 F. The one-piece gasket eliminates the need for close tolerances, and has no cold flow at any time. Stillman Rubber Co., 5811 Marilyn Ave., P. O. Box 1097, Culver City, Calif.

Air Duct Joints. A new line of high temperature (550 F) self-aligning-air duct joints is now available. Patterned after Monoball self-aligning bearings, the new joints have long cycle life, with 10 deg self-alignment and 360 deg rotation. Joints are available in bore size of 5 in. with operating pressures of 110 psi and a temperature operation of 550 F. Southwest Products Co., 1705 So. Mountain Ave., Monrovia, Calif.

PRODUCT LITERATURE

Teflon Machining. A folder showing facilities for custom-machining of Teflon parts is now available. The publication also displays the various types of components made of Teflon and lists tolerances on these parts. Plastics Products Sales Div., Raybestos-Manhattan, Inc., Manheim, Pa.

Resistance Thermometers. A booklet entitled, "How to Use Platinum Resistance Thermometers in Temperature Measurement, Telemetry, and Control," describes uses of these transducers in a variety of bridge circuits and control systems. Trans-Sonic, Inc., Burlington, Mass.

Precision Plating. In a 20-page illustrated brochure entitled, "Precious Finishes on Metals," emphasis is placed on the Hardas process for hard anodizing. Anachrome Corp., 10647 Garfield St., South Gate, Calif.

Elapsed Time Indicators. A bulletin sheet describes the 25200 series of subminiature hermetically sealed elapsed time indicators with 400 cycle motors, for operation on 115 volts. A. W. Haydon Co., Waterbury, Conn.

Corrosion Preventives. A chart of military-specification corrosion preventives gives data on 20 preventives, including solvent cutbacks, petrolatum barriers, general purpose preservatives and engine preservation lubricants. Information shown includes physical properties, application, removal, coverage and uses. Pennsyl-

vania Refining Co., Butler, Pa.

Magnesium-Thorium Alloys. An evaluation of these alloys, their properties and characteristics, originally presented as a paper before the Magnesium Assn., is now available as a separate folder. Brooks & Perkins, Inc., 1950 W. Fort St., Detroit 16, Mich.

Laboratory Activities. A 12-page booklet published by M. I. T. Lincoln Laboratory describes the organization's activities and fundamental research program. Subjects covered include the SAGE system, heavy radar, memory devices, transistorized digital computers, scatter communications, AEW, and systems analysis. M. I. T. Lincoln Laboratory, Box 24, Lexington, Mass.

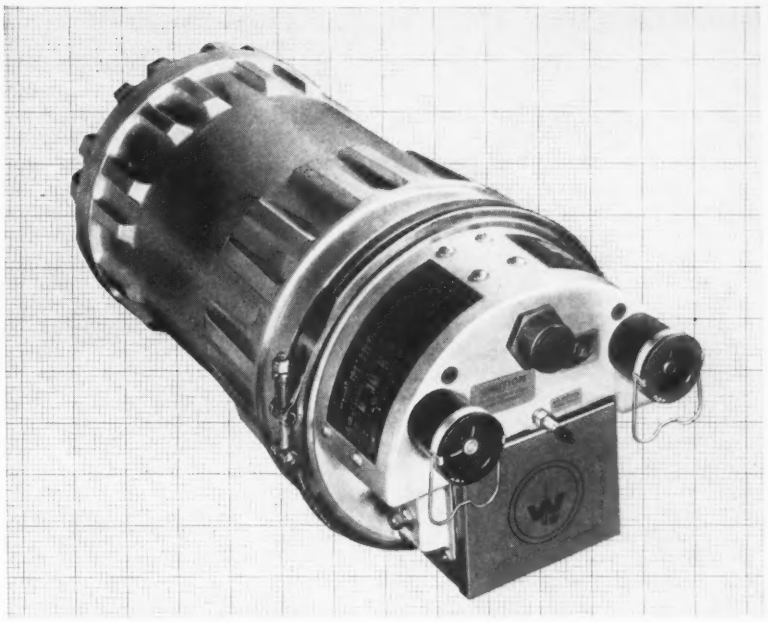
Titanium Availability. A quick summary of the availability lead times and prices of titanium mill products is the subject of two pocket-sized "Titanium Minute Readers." Titanium Metals Corp. of America, 233 Broadway, New York 7, N. Y.

Commercial Uses of Chemicals. Properties and typical applications of more than 100 inorganic and organic chemicals are described in a new Pennsalt catalog. It includes a section on inorganic chemicals listing many of the common volume materials, such as hydrofluoric acid, chlorine, caustic, ammonia, ferric chloride and hydrogen peroxide, as well as organic chemicals. Chemicals for rubber processing are included. Industrial Div., Pennsalt Chemicals Corp., 3 Penn Center, Philadelphia, Pa.

Squib-Actuated Switches. Specifications and engineering data describing the Series 300, 350, 400 and 450 squib switches have been published in a four-page fact sheet giving physical and electrical characteristics of these electro-chemical switches. Atlas Powder Co., Parke Thompson Ordnance Section, 9404 Watson Rd., St. Louis 19, Mo.

Phase Angle Voltmeter. Application Notes on Model VM-200 Series phase angle voltmeters provide set-up diagrams and procedures for research, test and production applications of the multi-functional instrument. North Atlantic Industries, Inc., 603 Main St., Westbury, L. I., N. Y.

Stainless Steel "Specs" Chart. A chart by means of which stainless steel Government specifications can easily be identified shows chemical analysis requirements for Military, Air Force-Navy Aeronautical, and Federal specifications. Peter A. Frasse & Co., Inc., 17 Grand St., New York 13, N. Y.



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Society and Space

(CONTINUED FROM PAGE 22)

institution with a traditional function to fulfill.

For many reasons it is obvious the first stage of our journey into space is tied to the military. But here, as in all other areas of human endeavor, motives are mixed, both as to the encouragement of military support by civilians interested in space studies and to the military's encouragement of space exploration. I would like to suggest, however, that, from the societal standpoint, somewhere along the line, and sooner rather than later, we had better examine the road we are traveling with this companion to see if it will indeed take us where we want to go.

While there are many related reasons for space travel, the two major ones which can be posed today are military demands and, almost the antithesis of that one, the sheer creative and emotional challenge of the fact of space exploration itself.

But, if the reasons for supporting space exploration are constantly phrased in terms of military requirements, it is not difficult to envisage the time when the only justification for research and development in this area will be in those terms, with the corresponding restraints that go with such terms. The fundamentally humanistic nature of space exploration can easily be lost sight of not only in the cross fire of conflicting political expedients, but even more so if the payoff is always perceived in terms of who wins the race and who can now lord it over whom.

And we might ask ourselves too, through how many steps in the exploration of space will the military find it technically worthwhile or politically expedient to support basic research? It should be clear enough that many of the activities which ultimately will be significant in the exploration of space will have no foreseeable direct or indirect military consequences or implications. Additionally, it should be remembered that the military can be interested in space exploration only so long as present strategic philosophies remain important. It is quite possible that, as the years go by, these strategies will change as a result of the development of other than nuclear types of unconventional weapons, and radical changes in delivery systems.

Such changes in weapons and strategy may make it imperative for the military to compete for funds in areas other than space exploration—areas where the chances of convincing Congress to finance new projects may be greater than in the space exploration field.

Will the Public Support It?

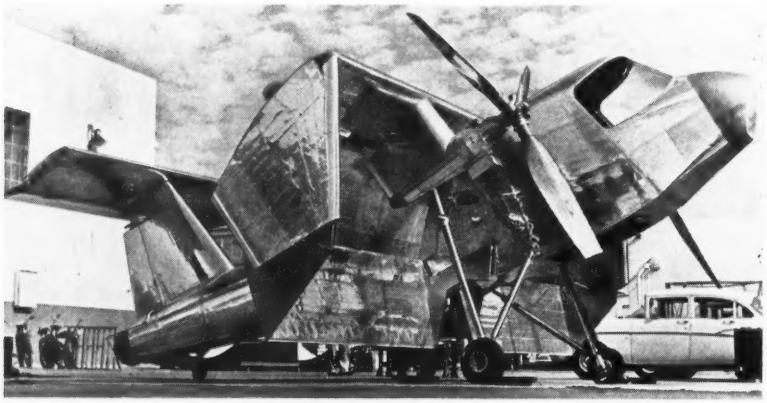
Now, what of public support for space studies? To what extent will the public be interested in seeing that space exploration is pushed on a large scale and with imagination? I would like to suggest, at least for the sake of argument, that there is, on the basis of present evidence and on our present understanding of the nature and function of public expression of private opinion, *no* good reason to believe that there will be strong pressure from the public for effort and expenditures in this area, *unless very special efforts are made to elicit it.*

For example, one might expect that the Sputniks and our forthcoming satellites would have alerted the public to the challenges and implications of space exploration, if anything would. But a few months before the Sputniks, 50 per cent of the American public hadn't heard of our satellite program, and five-sixths of a cross section of the population of Baltimore had no understanding of the program.

And after the Russian satellites were in orbit? Surely the public was then aware and alerted? The fact is that, when the Indiana University Extension Center asked students, "What do you think the effect of Sputnik will be on America's future?" 10 per cent of the first- and second-year students queried answered that they didn't know that the Soviets had launched a satellite!

In the light of these findings, two questions naturally arise: (1) How is it that, with all the assertions in Washington and in the news media about massive public preoccupation with, and reaction to, Sputnik, this isn't clearly the case? And (2), if the public is not particularly interested, why not?

The answers to both these questions are complex. Much research has been conducted by behavioral scientists on the nature of public opinion, its



Using the "deflected slipstream" principle, the Vertiplane uses large flaps to turn the propeller slipstream downward.

Gas Turbine Powers Vertiplane

Designed to take off and land vertically, hover and fly forward, the Vertiplane was built by Ryan for the Army under the technical direction of the Office of Naval Research.

The Vertiplane, a true VTOL aircraft, employs the "deflected slipstream" principle. It has two propellers, powered by a Lycoming T-53 gas turbine engine located within the fuselage, and double retractable wing flaps which extend far below the wing trailing edge. When extended, these flaps deflect the propeller slipstream downward, providing vertical lift for take-off, hovering and landing. For transition into horizontal flight, the flaps are retracted as the plane picks up speed, and the slipstream then flows horizontally.

The Vertiplane is 27 ft 8 in. long; 10 ft 8 in. high, and has a wing span of 23 ft 5 in. The plane is designed to carry two people and has a gross weight of 2600 lb.

sources, its psychological function for those holding opinions, its distribution and its implications for action programs. Most of the findings indicate that, for the most part and under most conditions, most people are not interested in or enlightened about significant and complex issues—their opinions (if they have any), government pronouncements and American mythology notwithstanding.

I would suggest that we do not equate editorial response, news media coverage and the responses of national leaders with the intensity, direction and duration of interest in the public. Essentially, what happens is that each person interprets such an event in terms of his own perception of his relationship to it. The editor's job and self-image is to editorialize; the senator "views with alarm," especially when his view corresponds to that of other individuals with whom he shares his life view; the news media cover an event because it is *news*.

But, to the man in the street, news per se does not require that he reexamine his way of life or readjust his values. News and novelty have a diversionary impact, but not necessarily impress or consequences. And the reason most people are not easily impressed permanently or altered in their views or interests is the other side of the same coin which results in the impressibility and alterability—for the time being, at least—of opinion leaders and policy makers. The matter is not close enough to most people's way of life to fit in with the values and behavior they have learned are important for successfully coping with day-to-day reality.

No Assurance of Funds

As long as man-in-space is perceived as a diversion, a novelty, and something essentially unrelated, or perhaps even threatening, to the average man's way of life, sources of funds and public support for space research will be a sometime thing. They will depend on occasional threats, such as those perceived in Sputnik, and on the immediate excitement of a newspaper headline.

To my mind therefore, the best hope for the future of space exploration, i.e., the best hope for a future civilization which will support space exploration in the *spirit* it deserves, lies in the implementation of a system of education that provides every man with what has been called a "humanistic" world view.

And by this I definitely *do not* mean that the educational problem is primarily one which will be solved if we turn out enough scientists and do enough basic research. Training more

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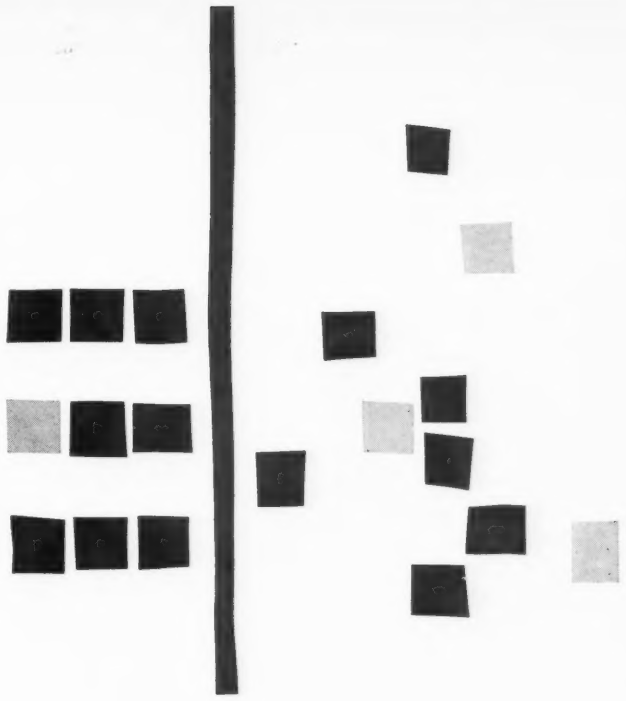

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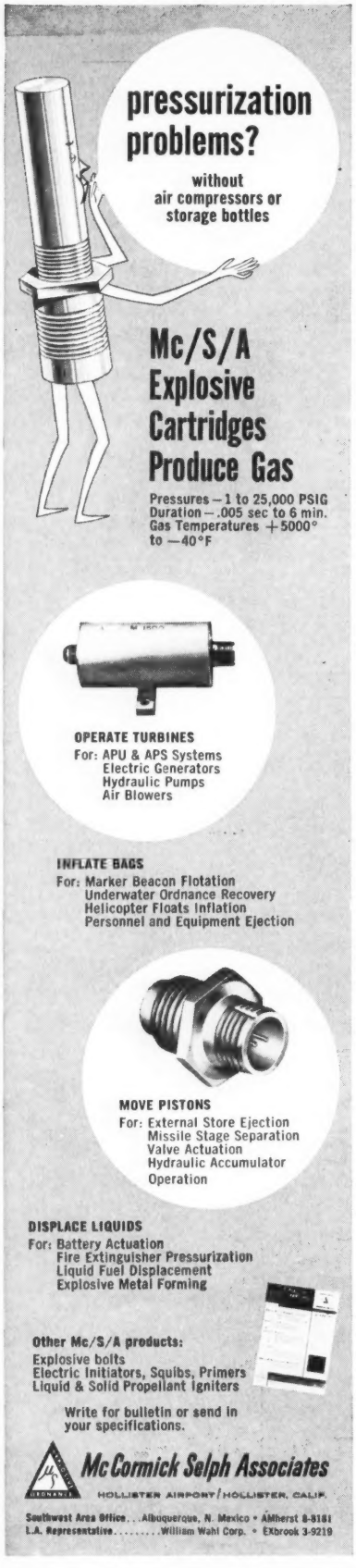


scientists will not of itself provide us either with the values or the social aspirations to solve the problems arising from the trends mentioned earlier, or to appreciate the experiences which will come to society as dividends from space exploration—even though it will undoubtedly provide us with the tools for solving the technological aspects of these social problems.

Nor, of course, am I saying that a basic knowledge of science is not a prerequisite for the humanistic world view. It simply is not enough in itself, and it certainly is not enough for the so-called man-in-the-street. Somehow we must teach people to know themselves both as individuals and as members of society in order that they may more significantly and consciously participate in the development of that society. I think this means that, if we want to explore space, man must better be able to explore himself. Hence, our success off this planet will depend in large part on the success of the applied and theoretical social sciences.

It is a curious and happy circumstance that the whole effort to put man in space provides special opportunities for increasing our knowledge of man's mind and his social behavior. But there is another special contribution which space research can make to our sociological and psychological research. It provides us with an ideal tool for the study of the basic processes of social change. (For those interested, the matter is discussed in detail in the June, 1957, issue of the *American Psychologist* by the author.)

Theories Can Be Tested

Suffice to say that man-in-space offers an unprecedented opportunity to test theories about social change. Obviously, the better our understanding of this process, the better the likelihood that we can make a world where the aspirations of space explorers, and indeed the aspirations of all enlargers of human horizons, can be fully realized.

Without this understanding of man and without translating it into the education of man, I fear for the meaning and the future of man-in-space. Unless we somehow begin this understanding and this education soon, our four-dimensional exploration of space-time may, through an immature and inadequate society, be warped into a flat and dreary world wherein man-in-space is just one more concept made trivial through the timelessness of day-to-day living and small imaginations.

Defense Dept. Action Urged To Solve Telemetering Problems

Prompt action by the Department of Defense to solve major problems existing in telemetering today was called for by Lawrence W. Gardenhire of Radiation, Inc., chairman of the 1957 National Telemetering Conference, in a recent letter to Paul Foote, assistant secretary of defense for research and engineering.

A meeting was scheduled between Conference officials and Defense Dept. representatives last month to discuss the matter.

The letter notes that little or no coordinated effort exists in the direction of an improvement program in telemetering, and that this lack "has been, and still is, a detriment to our missile and aircraft programs." The little that has been done is the result of more or less unofficial action involving the various missile ranges and private product improvement programs carried out by the telemetering industry.

Efforts have been made by the Conference to solve major problems, the letter goes on, but at the 1957 meeting it was found that the scope of the most pressing problems, defined as the split responsibility between missile range operators and range users, frequency allocations, and the lack of new and realistic standards, are beyond the capabilities of the organization and require prompt action by the Defense Dept. if our missile programs are not to suffer further.

Each of these problems involves the government to some degree, the letter points out, and a group commissioned by and responsible to DOD is regarded by the Conference as the best way to go about seeking solutions. The test ranges, range users and the telemetering industry should all be represented on the group.

The biggest problem, the letter says, that of split responsibility, would be solved by the very formation of the group. In addition, with official status and the cooperation of all concerned, the group could quickly recommend practical and efficient industry standards and frequency allocations to DOD.

The Conference also offered its services to aid in any way possible in the formation and operation of such a group.

For Want of a Nail . . .

The ballistic missiles program is costing the government over $1 billion a year. Using this figure for a frame of reference, Col. Henry Macdonald, assistant deputy director, AF Ballistic Missiles Div., went on to explain the complexity and importance of reliability in missile work to a group of some 200 San Fernando Valley manufacturers at a recent meeting in Van Nuys, Calif.

There are, Col. Macdonald pointed out, five major subsystems in a complete missile and 100 components in each subsystem. In order to successfully fire a complete missile even 50 per cent of the time, individual components must have a reliability of 999 in 1000.

As a nation, the colonel told his audience, we cannot afford from either a security or an economic standpoint to have a multimillion dollar missile misfire through failure of a $10 part.

Electronic Fault Finder Checks Missile Reliability

Each time the Army fires a missile, it wants to feel 100 per cent sure that it will work. To obtain this assurance, engineers of the Army Ballistic Missile Agency's Industrial Operations Div. have developed a defect reporting system, now in use on the Redstone and Jupiter programs.

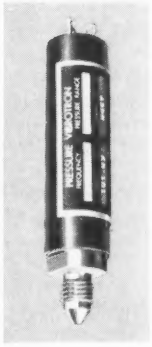
Basically, the system involves recording, collecting and processing in an organized way data from ABMA's development laboratories, from industrial contractors who produce the missile and its components, and from Army units using the missile systems in the field.

Defects in mechanical, electrical and other components are reported on IBM forms so that information from all sources can be correlated in processing. The IBM forms are funneled into the Agency's computation lab where they are processed by standard computer techniques. Similar data processing facilities are employed by contractors. As soon as a trouble area is pinpointed, the designers are informed and product improvement is initiated immediately.

Callery Developing New HE Solid Propellant

Callery Chemical Co., producers of HiCal boron-based high energy liquid fuels, has started work on the development of a high energy solid rocket propellant. Reportedly based on decarborane, the new propellant will be called, appropriately enough, "Solid HiCal."

rule out the bottleneck



You'll have time to pause and refresh if, unlike friend Sherman here, you've specified our Vibrotron Transducers for your flight testing. In case you're wondering, that's an F-106 Sherm is so ably piloting. We use it to illustrate that the people at Convair have found a way to simplify monitoring of *their* flight tests.

They mount two of our Vibrotron Absolute Pressure Transducers and matched amplifiers aft of the nose boom. One set measures total pressure, the other static pressure (altitude). As pressure variations occur, wire tension changes are fed into an FM/FM telemetering system. At the monitor, total pressure minus static pressure is *digitally* read out as airspeed. By this unquestionably advanced means, analog to digital conversion is bypassed, photo panel instrument hystersis overcome, intelligence transmitted a good long way without accuracy drop.

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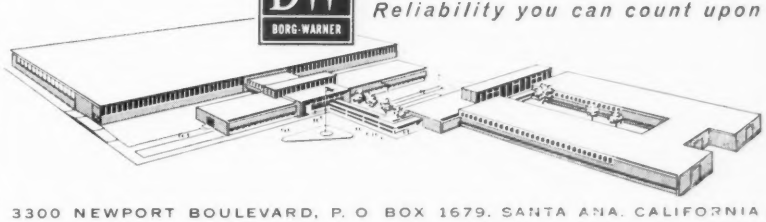

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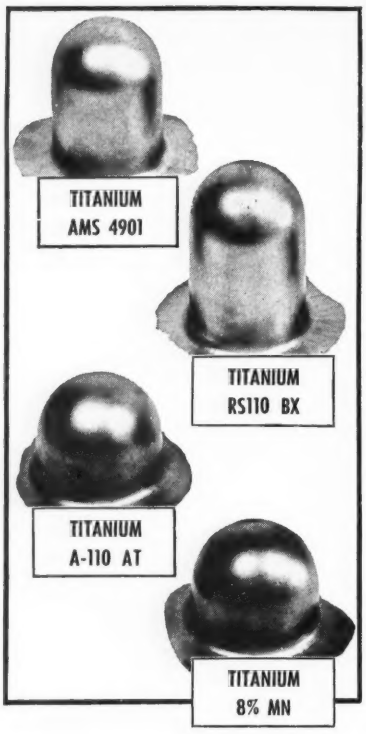

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Missile Market

(CONTINUED FROM PAGE 46)

with that of the general market. The major statistical services will undoubtedly follow suit in short order. In addition, more and more statistics on the industry as a whole will become available. These are heartening developments, for the uninformed investor is the least successful one.

Expenditures Will Mount

Governmental expenditures for missile development will continue to increase by leaps and bounds. From the modest $70 million budgeted in 1946 spending has already risen to the estimated $5.4 billion foreseen for fiscal 1958. This is only a beginning. Defense experts estimate that in the next decade or two, the defense budget must *increase* by at least $3 billion a year. Some sample expenditures in sight to successfully develop various projects are: IRBM, $7 billion; ICBM, $10 billion; anti-missile missile, $6.5 billion; manned satellite, $3.5 billion; and manned rocket to the moon, $5 billion.

All these observations on the past and future lead to no revolutionary discoveries. We can only repeat what we have said in the past. The industry is in a period of dynamic growth, which will be followed by consolidation, giving current opportunity to the astute long-term investor to realize substantial capital gains through careful selection and investment in equities in the guided missile and rocket field.

Much criticism has been aimed at the Dow-Jones Industrial Average. In essence, it is thought to be unrepresentative of the market as a whole, and to conceal too well conflicting movements of different industrial groups. Thus, while the all time high in the average came on April 6, 1956, many industrial groups and individual issues registered their bull market highs some 12 to 18 months previous to this date. Similarly, the 12 per cent decline in the average in 1957 conceals a much greater drop in many of the leading and most widely distributed issues.

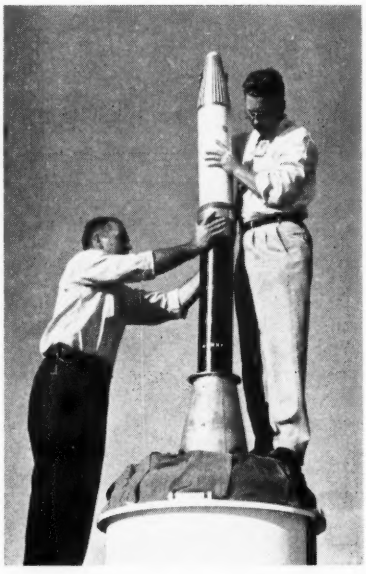
It must be pointed out that our missile index can be subjected to somewhat the same criticism. Thus, while it rose 6.6 per cent in calendar 1957, this rise can be mostly attributed to only three issues out of the 23 in the index. Ownership in these three, moreover, is very small when compared to any of many of the individual equities which declined. Actually, 11 stocks in the index declined by as much as 20–30 per cent during the year (mostly the aircraft companies), nine closed virtually unchanged, and the only significant increases came in an electronics company (Litton Industries, up 30 per cent), a chemical company (Thiokol, up 70 per cent), and a true missile company (high-priced Aerojet-General, up 100 per cent).

A further interesting observation about these three companies is that none of them was particularly well known to the general investor. Aerojet's small floating supply of stock is traded over-the-counter, Thiokol is on the junior American Stock Exchange, and Litton has only recently made the move from the latter to the New York Stock Exchange.

This seems to reinforce the writer's comment in an earlier column that "yesterday's sure and conservative investment may turn out to be merely an unsuccessful speculation, while the 'speculation' made today may be the soundest investment move possible."

It must be remembered that an index or average can never be more than a signpost on the road to successful investing by revealing major trends. It is realized, though, that the disparity between the index's movement and that of one's own portfolio will never be quite satisfactorily explained to the investor.

Ready Jupiter Satellite



Army satellite, prepared by Jet Propulsion Laboratory, is attached to the last-stage rocket (black) of the Jupiter-C by technicians of the Army Ballistic Missile Agency. Satellite and final-stage rocket are designed to orbit as a single unit.

Solar Photo Report Wins Newcomb Cleveland Prize

A report on solar photographs at the American Association for the Advancement of Science meeting at Indianapolis late in December won the $1000 Newcomb Cleveland award for the outstanding paper presented during a regular AAAS session.

The paper, by Martin Schwarzschild, J. B. Rogerson Jr. and J. W. Evans of Princeton University Observatory and Sacramento Peak Observatory, dealt with photographs taken last September and October through a self-aiming 12-in. telescope from an unmanned balloon at 80,000 ft.

Dr. Rogerson revealed that the next balloon flight with the 12-in. telescope is planned in 1959, while flights with a 36-in. telescope to make further photographs of the sun, as well as the planets, are planned late in 1960 or early in 1961.

Ballistic Rocket Seen Best for Long-Range Use

The ballistic rocket seems to show greater possibilities for use in long-range operations than either the boost-glide or skip rocket, according to H. Julian Allen, chief of the High Speed Research Div., NACA Ames Aeronautical Laboratory, Moffett Field, Calif.

In delivering the 21st annual Wright Brothers Lecture of the Institute of the Aeronautical Sciences at the Smithsonian Institution in Washington, D. C., in mid-December, Allen compared the relative efficiency of these three types of rocket vehicles and conventional supersonic aircraft. Title of the lecture was "Hypersonic Flight and the Re-Entry Problem."

After examining several of the problems particularly important for rocket vehicles, such as aerodynamic loads and stability and, most important, aerodynamic heating, Allen, recipient of the highest NACA award, the Distinguished Service Medal, for his work on blunt nose cones, indicated that the ballistic rocket appears most attractive for long-range flight. The boost-glide rocket may also be useful, he noted, but not the skip rocket.

In a brief discussion of the paper which followed the lecture, Antonio Ferri, director of the Aerodynamics Laboratory of the Polytechnic Institute of Brooklyn, suggested that conventional aircraft should not be dismissed so lightly and that multistage aircraft might be one possibility for long-range operations.

Wallace F. Hayes, professor of aeronautical engineering, Princeton University, commented that he was glad to see the ghost of the skip vehicle laid to rest but added that boost-glide rockets still appear promising for use as manned vehicles.

Hermann H. Kurzweg, associate technical director of aeroballistic research, U. S. Naval Ordnance Laboratory, praised the paper for its clarity, holding it up as a model for future studies of this type.

National Observatory Planned in Arizona

The National Science Foundation has entered into contract with the Assn. of Universities for Research in Astronomy, Inc., (Aura) for the conduct of basic research in the field of astronomy and for the construction, operation and maintenance of a National Astronomical Observatory. The sum of $3,100,000 was appropriated by the NSF for fiscal 1958.

Aura, Inc., with principal offices in Phoenix, comprises the following universities: California, Chicago, Harvard, Indiana, Michigan, Ohio State and Wisconsin. These universities joined to constitute a management group for the observatory because they have strong programs of research and graduate instruction in astronomy.

The observatory will include 36- and 80-in. telescopes. The site will be selected after tests for visibility conditions. Three sites in Arizona are now being evaluated by the University of Michigan, which has been awarded $800,000 for the purpose.

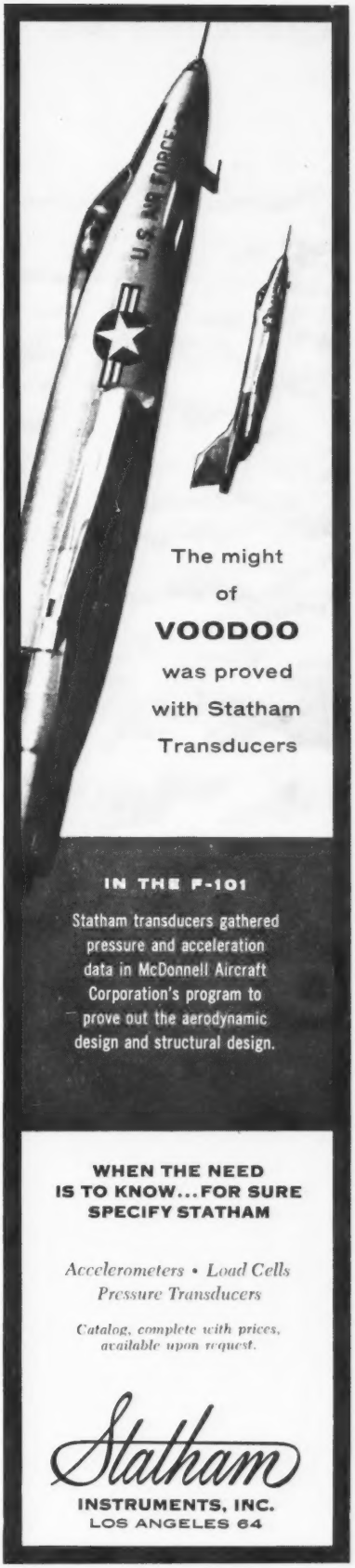
As the project develops, it is expected that other universities and individuals will be added to Aura, Inc. The observatory will be available to all qualified astronomers for research work.

IGY Meteorological Data Available on Microcards

World Meteorological Organization announces the availability of microcards containing IGY meteorological data. Essential data recorded during IGY will be published on four types of microcards, corresponding to the four types of standard forms in use, and covering Synoptic Surface Observations—Land Stations; Synoptic Surface Observations—Sea Stations; Radiosonde and Rawinsonde Observations; and Upper Wind Observations.

Total number of microcards is estimated to be 18,500. The cards will ultimately be sold in complete sets, partial sets or individually.

Information may be obtained from World Meteorological Organization, IGY Meteorological Data Centre, 1 Avenue de la Paix, Geneva, Switzerland.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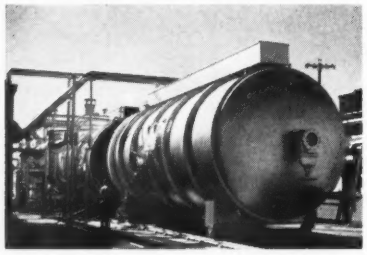

Convair's new vacuum test chamber, built under USAF contract.

Convair's new $1 million vacuum test chamber at San Diego is now ready for operation. Large enough to enclose a complete fuselage of the F-106A jet interceptor, the steel chamber is designed to check efficiency of fighter's electronic systems at altitudes to 100,000 ft and at temperatures to 830 F (the equivalent of aerodynamic heating at speeds to Mach 3).

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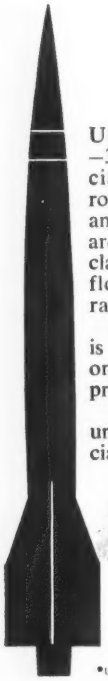

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Italians Up in Arms

Sometime this year, the Italian Army expects to set up three Nike-Ajax and two Honest John missile units. For future use, the Italian government is also considering the following missiles: Nike-Hercules, Bristol Bloodhound, Fairey Fireflash, D. H. Firestreak, Falcon and Sidewinder.

Moreover, Italy soon hopes to start producing its own missiles. During a recent military display, Italy showed its first air-to-air missile to technicians and journalists. It is an infrared guided, solid propellant rocket now in the experimental stage. Designated C-7, the missile is 5 ft long, about 8 in. in diam, and has a rectangular wing configuration. It was exhibited on a standard F-86E fighter used by the Italian Air Force.

Meanwhile, Contraves Italiana is building the Swiss Oerlikon 54 guided missile in Italy under license. The missile, a beam rider, is powered by a liquid propellant rocket engine.

Oxygen Outstrips Demand

For the first time since the start of World War II, oxygen output in the U. S. now exceeds supply, according to W. M. Haile, president of Linde Co.

Among the factors accounting for this increased supply are new Linde production facilities now on stream at Ashtabula, Ohio, and Fontana, Calif. Expansion at these LOX plants is adding 150 million cu ft of oxygen a month to national output.

In addition, more and more large oxygen consumers, particularly in the missile field, are turning to the use of on-site plants, producing what amounts to from ten to hundreds of tons of gaseous oxygen a day, much of it in liquid form.

Not counting this captive production, the U. S. is now turning out about 32 billion cu ft of high purity oxygen a year. This represents almost a 100 per cent increase in a little over a decade.

How much of it is finding its way into the missile program? Educated estimates place the figure at 5 per cent of reported, noncaptive production. This is the same percentage of its own production that Linde, a major supplier, estimates it sells to the missile field.

Punch Bowl Engineers Hold Annual Meeting

Harry W. Smith, Inc., technical advertising agency whose Christmas parties have become a New York tradition, this year invited its friends to its 9th Annual Decantation at Yuletide, held in collaboration with the Society of Punch Bowl Engineers.

Announcement of the party, made up in the form of a technical meeting program, listed the following papers:

"Meteorological Influences on Random Satellite Sightings in the Hebrides: An Appreciation of Scotch Mist," by Titus A. Drum, Cloud Chamber Supervisor, Bog, Marsh & Fenn, Inc.

"In Vitro Experiments with Artificially Induced Auroras: Details of a New Process for Quick-Freezing Daiquiris using Polarized Light," by Asa Earlop, Director, Glow Detection, Icepack Research Institute.

"Schott Glass Studies of Diffraction, Diffusion and Obliteration: A Rigorous Approach to the Classic Barstool Problem Using Latest Mooching Techniques for Experimental Set-Ups," by Cassius Short, Orbit and Fallout Coordinator, Unidentified Flying Object Development Corp.

The program also listed a presentation, the Dutch Schultz Memorial Award, going to the member "who, in the judgment of the Society, made the greatest contribution in 1957 to the annoyance of the Alcohol and Tobacco Tax Division of the Internal Revenue Service."

New Thermometer Device Extends Aircraft Range

To help aircraft increase their range and save fuel, a "vortex thermometer" has been developed for the AF Air Research and Development Command. The device gives pilots direct, true, free air temperature readings while traveling at high speeds.

Developed by the Armour Research Foundation of the Illinois Institute of Technology, the thermometer assists the pilot in locating jet streams and the position of maximum velocity in them. The thermometer was found to be effective at simulated altitudes up to 40,000 ft and speeds up to Mach 1.1.

Tit for Tat

Atlantic Research Corp. has granted Thompson Products, Inc. exclusive license to purchase, use and sell AR's new Arcogel propellant. At the same time, Thompson gave Atlantic a $30,000 contract for continued development of the propellant and associated burner systems.

Both firms will work on the design of complete systems utilizing the propellant. And, under the agreement, Atlantic will receive royalties on any sales of the gel propellant or burner systems.

In Print

(CONTINUED FROM PAGE 10)

Man Among the Stars, by Wolfgang D. Müller, Criterion Books, New York, 1957, 307 pp., illustrated.

Here is a book which, while it will not be found wholly satisfactory by either the Romantics or Skeptics of space flight, is worthy of a high place in any listing of tomes dealing with this subject.

For Mr. Müller, a German science writer who is now editor of the monthly atomic energy publication, *Die Atomwirtschaft*, is first and foremost a reporter, and he never forgets that the first duty of a reporter is to give his reader the facts. And facts are what he supplies in this calm, lucid, reasoned introduction to the entire subject.

In eminently readable style, Mr. Müller carefully details the beginnings, progress and future prospects of space flight, and along the way provides us with a number of carefully researched and interesting essays on such diverse subjects as religion in space and the possibility of finding creatures on other worlds, as well as capsule histories of astronomy, exploration and even space literature.

While a good deal of the material contained in the book will, of course, be familiar to ARS members and some of the material is already outdated, its scope is such as to make it of interest to all space flight enthusiasts. In addition, it is refreshing to find a work on the subject in which the author is not intent on pressing his own theories on the reader.

Along with the historical background and an analysis of current and future problems, Mr. Müller includes a long chapter on flying saucers. While here again the author is careful not to take sides, it is obvious from the strong dose of skepticism that underlines this portion of the book that, in this instance, at least, he stands with the nonbelievers.

While it would seem at first impression that a saucer chapter would have no place in a book of this kind, Mr. Müller presents a rather interesting reason for its inclusion. To him, the saucer phenomenon is an outgrowth of space consciousness, his point being that "it was by no means the appearance of these strange phenomena in the heavens that first made us conscious of distant worlds—it was just the other way about." From this standpoint, perhaps the inclusion of this chapter was logical.

It is only in the last chapter, a consideration of the implications of space travel, that the author takes sides, or at least waxes philosophical for a moment. Like Krafft Ehricke (see November ASTRONAUTICS, page 26), he believes space flight will act as a spur to man, and can make him "the founder of new realms . . . the master of new techniques which (will) provide him with the power, independence and freedom to overcome ever new and daring tasks . . . a seeker and explorer ever full of new plans and ideas, looking forward to new goals."

A few conventional photographs are included, along with a five-page bibliography of space flight which, despite an overabundance of saucer material, is as complete and up-to-date as any ever compiled for a popular work of this kind.

Among nontechnical works on the subject, "Man Among the Stars" stands almost alone in its calm, reasoned tone, providing a sharp contrast to the frenetic note of most such books. As such, it deserves a spot on everyone's bookshelf. —I. H.

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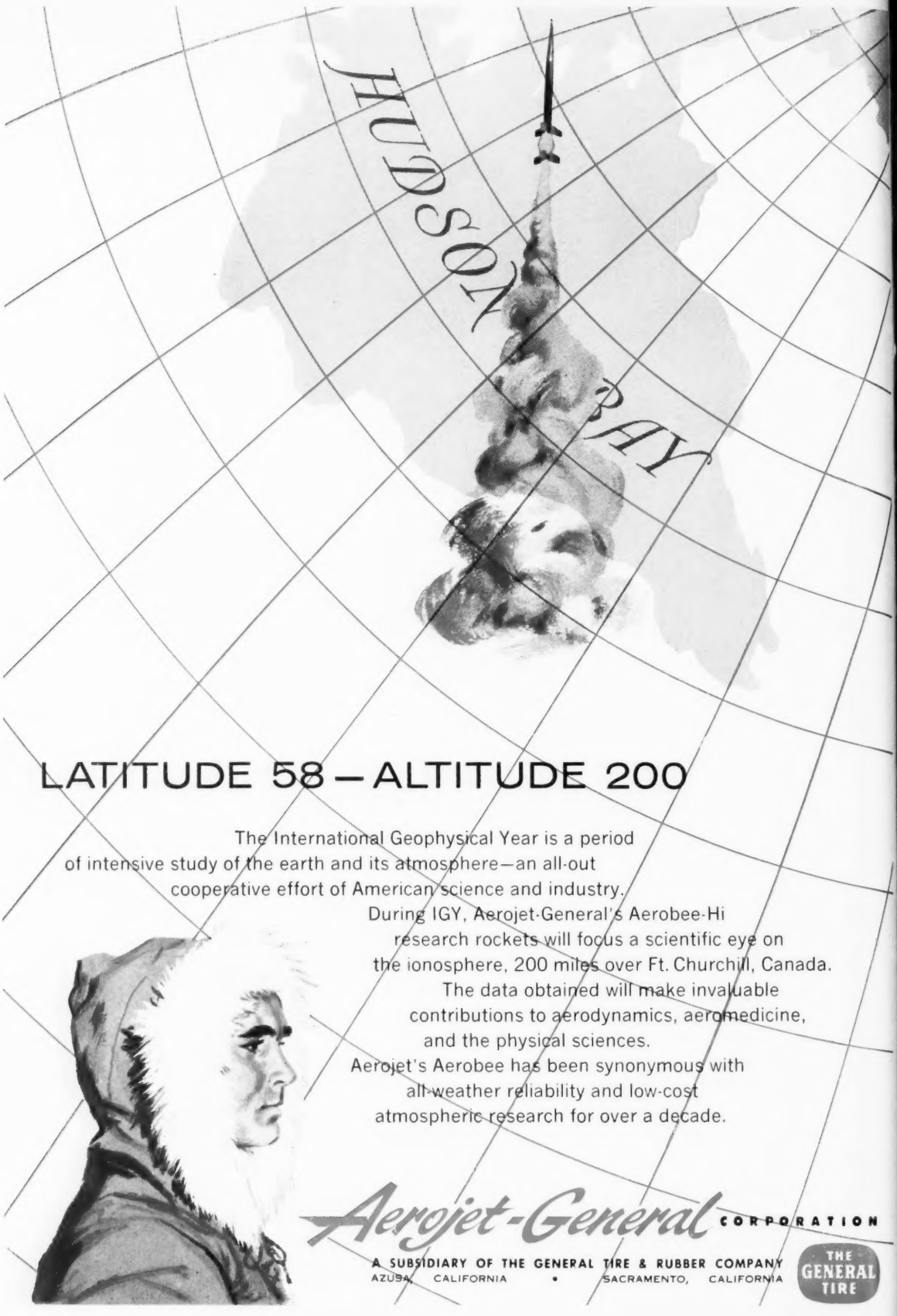

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